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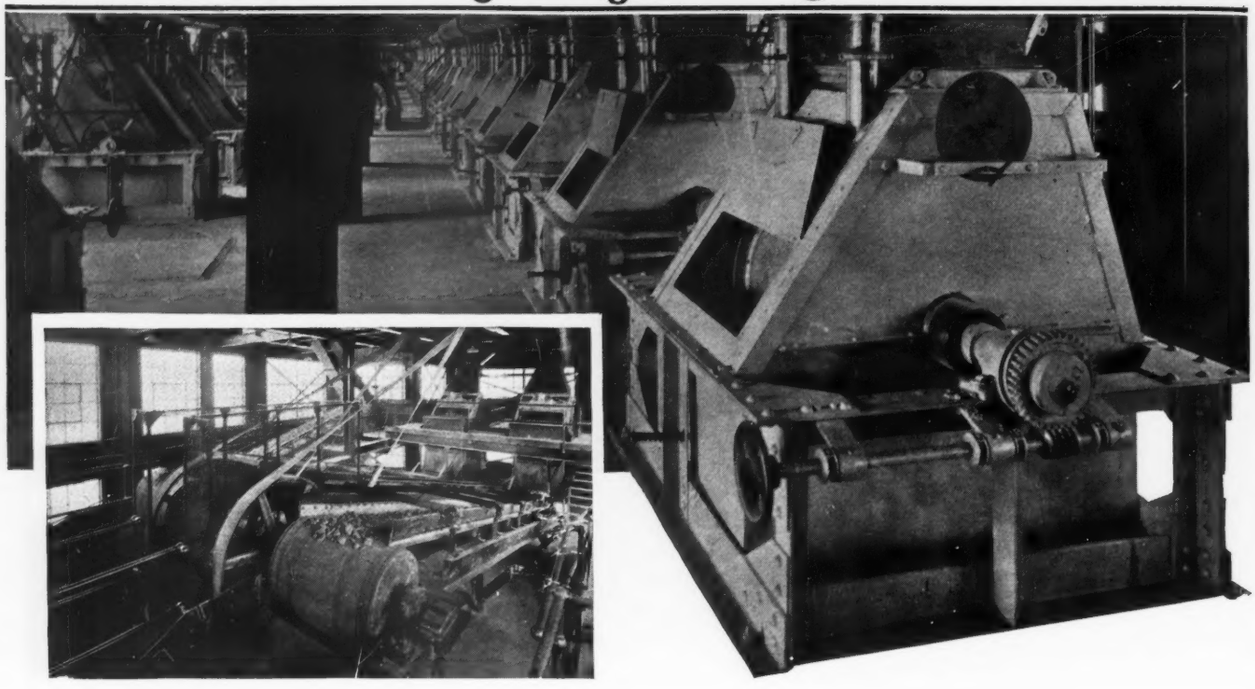

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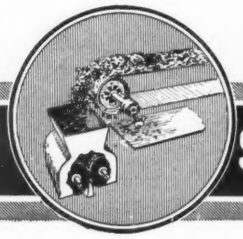

Magnetic Separators

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War Minerals Relief Again

ANOTHER ATTEMPT to get "relief" for the unsatisfied war mineral claimants is to be made. Once more Congress is to be importuned to repair the losses that these individuals and companies are alleged to have experienced when they rushed to aid the country in its hour of need, by producing, or preparing to produce, manganese, pyrites, chrome, or tungsten in compliance with the request of certain agencies of the government.

The reader must not assume from this that those who undertook to produce war minerals at the stimulation of the government have been languishing unrelieved since the Armistice. No, indeed! The provisions of the act of March 2, 1919, included an appropriation of $8,500,000 to provide relief in all legitimate cases. The Relief Commission, consisting of Philip N. Moore, John F. Shafroth, and Horace Pomeroy (successor to M. D. Foster, who died in office)—all men above reproach—completed its work in the spring of 1921, having disposed of all claims save about one hundred, which were left for the Secretary of the Interior (Fall) to ratify, and leaving $4,500,000 of the original appropriation unexpended.

A strong similarity exists between the attraction of a group of politicians toward an unspent appropriation and that of a swarm of flies toward a pot of honey. This unexpended balance of the War Minerals Relief appropriation simply had to be disposed of. Secretary Fall, now better known than then, had come into the office which had been so honorably filled by Mr. Lane, who had passed away some time before. Accepting the resignation of the retiring commissioners, he appointed a single individual—a politician—in their place. In November of that year (1921), the Secretary consenting, more liberal relief legislation was passed by Congress, admitting many claims excluded under the earlier Act. Going Congress one better, Secretary Fall then let it be understood that he wanted a liberal policy to be pursued—that minute examination of claims was quite unnecessary.

So rapidly was the fund then disbursed that by the fall of 1923 payment of relief awards had to be suspended, because the total already paid was nearing the $8,500,000 appropriated. The outstanding unpaid claims by this time exceeded the unexpended balance. Congress in June, 1924, almost in its last hours, did away with this embarrassment of insufficient funds by removing the limitation in the existing law precluding payment of claims in excess of a total of $8,500,000.

Secretary Work succeeded Mr. Fall. The going became less easy for the pork dispensers. In December, 1925, Mr. Work reported that the last claims had been disposed of and that more than $950,000 remained unexpended out of the original appropriation. Return of this balance to the Treasury was prevented, however, by the politicians, who now cast about for new pretexts for transferring this money into the pockets of their clients, or supporters, political or otherwise. To the credit of Secretary Work, it should be recorded that up to the present moment he has successfully fought all efforts to secure the passage of new "liberal" legislation which has for its object the disbursement of the $962,000, approximately, that remains of the original appropriation.

Uniform Systems of Metal Mine Accounting

MINING ENTERPRISE, in common with virtually all other undertakings of any size in the present-day industrial world, is financed by the public, through ownership of corporate shares. Consequently, it is highly desirable that the industry conduct itself so as to win and deserve the confidence of the investing public. One means toward this end is to make the published quarterly and annual reports as informative and as understandable as possible. It is conceivable that special conditions may exist under which it would be prejudicial to the best interests of the shareholders to have some details of the corporate affairs disclosed with too much frankness; but such a set of conditions should arise only rarely. Generally speaking, an accurate and a complete picture of the company's position should be reflected in the reports.

One of the peculiarities of mining is that a correct presentation of the position involves elements that must be estimated to a greater degree than in many other kinds of enterprise. Ore reserves and future market prices for metals are important factors that must be approximated. One requirement of a satisfactory report is that matters of fact should be clearly differentiated from matters of opinion.

The incidence in recent years of the income tax law, with its provisions regarding obsolescence, depreciation, and depletion, has resulted in a tendency to modify methods of cost accounting. Likewise, the large capital investment that usually is required to equip a modern mining and reduction plant has had a similar effect. One unfortunate result has been the adoption of dozens of methods or systems of accounting; so that, even with respect to mines of similar character, it is impossible to compare production costs and earnings with any assurance of fairness.

Copper producers, through the recently formed Copper Institute, have arranged to submit details of their production costs to a firm of certified public accountants from

which *en bloc* data for the whole industry are to be compiled. It seems not unlikely that use may be found for these data in demonstrating to the public or to government agencies that the average earnings are inadequate in view of the fact that an ore deposit is a wasting asset. But if the figures are to be of real value they should be based on some standard method for utilizing the original entries in the accounts of the various companies.

Still other advantages may be suggested from drawing up a set of model forms or patterns for adequate mining-company reports. In general, the principles would be the same; but details would vary according to the type of operation involved: with the kind of deposit, and the metal mined. Recently a special committee of the Mining and Metallurgical Society of America has undertaken to devise such a set of standard reports. The plan is a good one, and the officials of mining companies might well co-operate if co-operation is asked.

Scope for an Alternative to Air in the Flotation Process

FROM a study of the literature of the flotation process it would seem that little attention has been paid to the chemical properties of the air used as a lifting agent, although under normal operating conditions the oxidation of a sulphide has been noted. The possibility of taking advantage of a weak chemical affinity or selective action between a gas other than air and a metal or metallic compound offers scope for investigation, although much research and experimentation on the adjustment of selective action would doubtless be necessary, as was found essential in the development and application of the standard and original process.

The ordinary flotation process, using air, has been applied only to a small extent in general industrial work; and it has made little headway in the chemical industries for the separation and recovery of crystalline products, most of which are essentially chemical compounds and therefore in the same class, chemically, as ore minerals. Air has been used most successfully in the flotation of iodine from mother liquor that has been "cut" with bisulphite or other agent; and the effectiveness of the separation is an indication of an affinity that appears to exist between the oxygen in the "gas" used and the somewhat heavy element lifted. It seems reasonable to infer the beginning of a chemical reaction, and the production of a minute amount of an oxide, a reaction analogous to what doubtless occurs when a mineral containing oxygen shows a preference for a reducing gas.

Low-grade free-gold ores exist in large quantities. If the normal application of the cyanide process is too costly, may it not be possible to take advantage of the beginnings of a chemical action between the gold and the oxygen and cyanogen needed for dissolution, to which might have been added bromine or iodine or some other "corrosive" accelerator? Might not such a mixture of gases exhibit a preferential affinity for the precious metal, and, applied under suitable conditions, lift it to the surface? The collection and re-use of the gas would be practicable. If some of our metallurgical friends could be induced to "think out loud," some interesting comments might result.

Saving Weight in Mine Equipment

MASSIVENESS does not necessarily betoken strength. Castings used in earlier models of various machines have been replaced with forged steel parts, giving a product of greater strength and longer life and occupying less space. Another step in making a more compact, lighter and stronger machine is to be found in the use of welding instead of riveting in fabrication. Still another step is possible—the substitution of metal alloys, stiffer and stronger than steel, in place of steel whenever conditions, price included, permit. Bars of such metals were exhibited recently by Dr. Zay Jeffries, before the New York Electrical Society. When arranged as miniature cantilever structures, it is said, one of these bars sank only one-seventh as much under a given load as a bar of standard steel of the same width and weight. A great expense of modern industry is the cost of moving weight, said Dr. Jeffries. A railroad train or street car must move not only the weight of the passengers but its own weight also. Use of the new strong alloys is a revolutionary feature of the present tendency in transportation. The experimental street car designed by Mr. J. R. Blackhall, vice-president of the Chicago and Joliet Electric Railway Company, weighs only 447.4 lb. per passenger, against approximately 900 lb. in the present type of car, according to the Aluminum Company of America.

Duralumin is being experimented with in Germany in the manufacture of small mine cars, it is reported. It is not unlikely that the next decade will see manufacturers of mine cars elsewhere paying more attention to this matter of saving weight in their product, especially if it can be accomplished without a sacrifice of length of life and strength. Engineers and draftsmen must develop an attitude of "weight mindedness," as it has been called, with respect to mine equipment that goes underground and is moved long distances over rough roads, if the full benefit of modern discovery is to be realized.

Canada May Claim Second Place As a Gold Producer

WILL Canada's gold production in 1928 exceed that of the United States, the former country thereby replacing the latter as the second largest gold producer of the world? A moot question this, one that has recently received considerable attention in both countries, particularly on the part of those interested in the advancement of the mining industry of the Dominion.

That the United States cannot retain much longer her present position seems evident. Since 1915, the year of record production, the country's gold output has steadily declined, whereas Canada's gold mining industry has gone forward, her 1927 output being more than twice that for 1920.

Statistics credit the United States (including Alaska and the Philippine Islands) with a 1927 production valued at $45,027,300; Canada's is placed at $37,731,080. Compared with the records for the preceding year, these valuations represent a decline of 6.7 per cent for the former country and an increase of 4.0 per cent for the latter. On the basis of these valuations and rates of increase and decrease, Canada's 1928 output should

continue to be less than that of the United States, by more than $2,500,000. Recent Canadian statistics, however, indicate that such reasoning will not furnish a reliable answer to the question.

In December, gold production from the Kirkland Lake and Porcupine camps in Ontario was at an annual rate exceeding $40,500,000, although the 1927 total output for these districts was only slightly more than $33,000,000. Continued increasing production from these camps is expected in Canadian mining circles, and $25,000,000 for Porcupine and $15,000,000 for Kirkland Lake are therefore considered conservative estimates of 1928 production. To this total of $40,000,000 is to be added the output of British Columbia, valued at $3,805,240 in 1927, and that of Yukon, Nova Scotia, Manitoba, and Quebec. The last-named province, which had a negligible gold production in 1927, is expected this year to yield at least $1,000,000 in gold from copper-gold ores. Totaling the "expectations" mentioned, which by no means cover all the gold production looked forward to in 1928 throughout the Dominion, an approximate figure of $45,000,000 is reached—the output of the United States in 1927. The thought that 1928 will be Canada's "passing year" in gold production, therefore, seems well justified.

Research Needed in the Borax Industry

NEW DISCOVERIES in the Mojave Desert region and their exploitation have disturbed the borax market. The comparatively recent development of certain commercial processes for efficiently handling the brines of Searles Lake brought into the market substantial quantities of borax obtained as a byproduct from potash production. This byproduct borax directly competed with the borax derived from the colemanite deposits of Death Valley and Las Vegas. Eventually the market adjusted itself to this situation, but the discovery of a large deposit of a new borax mineral changed the existing status. The colemanite beds rapidly lost their economic importance, and commercial borax is now supplied largely by the brines of Searles Lake and the rasorite of the Mojave region. Apparently the supplies from these two sources are more than ample to supply the demand for many years.

The sources of borax supply are largely in the control of three companies. Price cutting has been the result of competition in the relatively restricted borax market as well as in connection with other products derived from borax. The situation repeats conditions that have affected the non-metallic mineral industry in other lines and at different times. If it be admitted that there is more than enough borax, or raw materials from which it may be derived, to supply existing requirements, the situation can best be met, not by price cutting, but by systematic research in extending the uses of borax and its compounds. Colemanite can find a new outlet in the ceramic and glass industries, but research is necessary. The raw products must also be standardized as a preliminary to systematic utilization in other industries. An opportunity offers, for the companies interested in borax production as well as for the U. S. Bureau of Mines.

Tribute to Marshall's Memory

THE eightieth anniversary of Marshall's discovery of gold in California was recently given appropriate recognition by Californian organizations interested in the history of that state. The date of discovery, Jan. 24, 1848, is important in the mining history of the United States; not only did it start the drift of population toward the Far West, but, still more important, it awakened a widespread interest in the mineral wealth of the nation. Those who trekked to the West were keenly alive to the importance of prospecting. Out of the mining experience gained in the gold fields of California, a mining people developed that went into the business of mining. Knowledge of mining began to grow, and out of this beginning has developed present knowledge, educational facilities for spreading this knowledge, mining publications, government bureaus for research, and statistical records. Exploitation of mineral deposits is largely responsible for the growing accumulation of national wealth.

When Marshall said: "Boys, I believe I've found a gold mine," he did not know that he would thereby steer the nation into a new avenue of industrial progress. Although gold had already been discovered in California, little attention had been given to the fact. Marshall's discovery was under different circumstances and at a time when there was need for some inducement other than climatic advantages to populate the territory of California. The gold rush of '49 did it, scattering pioneers and adventurers generally throughout Pacific territory. On a more stable basis is the West of today, with research and initiative affording wide opportunity for a broad program of industrial development.

The Economy of Efficient Bearings

HOW important bearings are! On them moves the entire output of the mining industry from the face where the ore is broken to the furnace where it is reduced to metal. Bearings carry the load, whether it moves in mine cars to the shaft, or on conveyors in the mill, or on the railroad to the smelter and ultimate consumer. Depending largely on the bearings, the product travels with ease or difficulty, with corresponding consumption of power or expenditure of effort. Witness the trammer underground, in a mine poorly equipped and badly managed. Unless the grade be unduly steep, running cars to the station calls for extra effort, which might be better spent in shoveling or loading a larger tonnage. Under such conditions, the waste of man-power is difficult to estimate. Where mechanical haulage is used, however, the additional power required to move a train of cars equipped with faulty bearings can be directly measured. In a test made on a certain steel mill, after it had been re-equipped with anti-friction roller bearings, the saving that could be made in power was amply illustrated. To drive the mill, a 500-hp. motor had formerly been used. The engineers designing the new equipment declared that a 250-hp. motor would certainly be sufficient. The test showed that 112 hp. was required to handle the running load and only 12 hp. for the idling load. This was an eye-opener for the management. Small wonder that the use of anti-friction bearings has increased so markedly.

WILLIAM BRADEN

American Mining Engineer Who Pioneered the Revival of the Chilean Copper Industry

CHILE and the State of Indiana each possess a city named Valparaiso, but a more important coincidental connection between the two is seen in the fact that 24 years ago the potentialities of the low-grade copper deposits of Chile were brought to the attention of capital in the United States by William Braden, who was born at Indianapolis, Ind., on March 24, 1871. His career, after discontinuing studies at the Massachusetts Institute of Technology in 1889, has been varied. Through his initiative, an influx of American capital into Chile commenced, with the result that attention was directed to copper deposits of great importance.

MR. BRADEN'S first appointment, in 1889, was an assistant to the engineer of the Montana company, at Marysville. After a year there, he made a complete survey and plans for the recently organized Elkhorn Mines, Ltd., and then went to Butte as an engineer with the Anaconda company. In 1892 he became chemist and later assistant superintendent at the Arkansas Valley Smelting Works, at Leadville, Colo. In 1893 he went afield, as engineer in charge of the mines and interests of the Omaha & Grant Smelting & Refining Company in British Columbia. He also investigated mineral resources in Chile and Peru and made various examinations in North America as a partner of Braden Brothers, at Helena, Mont. During 1898-99 Mr. Braden was active in the famous litigation between Heinze and the Boston & Montana and Butte & Boston interests, as engineer and later as chief technical witness for the two companies. At the conclusion of his work in this litigation and until 1900 he made examinations in the western United States, Mexico, and in Canada. From 1900 until 1903 he was in the operating field as general manager of the Bruce Mines, in Ontario, after which he became general manager for the Velardena Mining & Smelting Company, in Mexico. These twelve years' experience in extensive operating and examination work gave Mr. Braden an adequate background with which to evaluate correctly mining property. Mr. Braden arrived in Chile in 1904 for the purpose of examining and negotiating for the purchase of the property known as "El Teniente." Having accomplished this satisfactorily, he returned to New York and obtained capital for the development and equipment of the property for operating with an initial capacity of 250 tons per day. Mr. Braden organized a corporation which his financial backers insisted on naming the Braden Copper Company against Mr. Braden's protests. Mr. Braden became general manager and director and continued as such for five years.

THE mine had been abandoned for many years and there was not even so much as a habitation upon the property; therefore, the first program undertaken by Mr. Braden involved the construction of a cart road 35 miles long, a concentrating mill, a 1,000 hp. hydro-electric plant, three aërial tramways, mining equipment and living and commissary quarters for staff and workmen. By 1909 development of the property had proven ore reserves of some 4,500,000 tons and indicated further large tonnage which made it appear that the mine would become one of the world's great copper producers. Therefore, it was considered expedient to effect a reorganization to provide new capital for equipping and operating upon a larger scale. This financing was undertaken by Guggenheim Brothers. Mr. Braden retired as manager, but remained a director of the company for some years and was principally instrumental in the adoption of flotation at this property, incidentally, the first large copper mine in America to adopt flotation.

Being free for examination and exploration work, Mr. Braden associated himself with the Anaconda Copper Mining Company, and, with a corps of engineers and geologists, conducted under his management a campaign of reconnaissance in Chile, Bolivia, and Peru. As a result of his activities he developed the Potrerillos mine (Andes Copper Mining Company); the Lo Aguirre and Africana mines (Santiago Mining Company), near Santiago, Chile; and the Cerro Verde mine, in southern Peru.

IN 1918 Mr. Braden retired from field work and made his home in New York City. Here, in association with T. Coleman du Pont, Messmore Kendall, and Edward J. Bowes, he interested himself in the construction of the Capitol Theatre, on Broadway, at the time built the largest theater in the world. In 1919 he was joined by his son, Spruille, who, having graduated from Yale University as a mining engineer, had worked in his father's organization in Chile. Mr. Braden has diversified his interests and activities in such things as New York real estate operations, development of petroleum, agricultural, and timber properties in Bolivia; he became a stockholder and director in the banking firm of Blair & Company; and has become interested in a carpet and rug manufacturing business and the textile industry; all of

WILLIAM BRADEN

which have been measurably successful, but ties other than these mentioned always ally him with Chile and South America.

Between 1919-22, Mr. Braden's son succeeded in interesting the Chilean government in the project of electrifying part of the Chilean state railroads, in connection with which Mr. Braden's ripe experience served as an excellent background for the son's guidance.

Mrs. Braden has been the only woman decorated by the Chilean government with the Order of Merit of O'Higgins; his son, Spruille, is married to a Chilean lady of Santiago. Mr. Braden, moreover, developed many friendships, while in Chile, and he stands pre-eminently as the pioneer messenger of good will to a republic that can now boast of holding second place as a world copper producer, largely through his initiative.

Mr. Braden is now president and director of the Braden Realty Corporation and of the Kingscote Realty Corporation. He is a director of the Metro-Goldwyn Picture Corporation, a director and trustee of the Moredall Realty Corporation (Capitol Theatre), vice-president and director of the Santiago Mining Company, a director of Monmouth Rug Mills, Inc., and president and director of Cohoe Processes, Incorporated.

Fundamental Factors Underlying *Electrical Methods of Geophysical Prospecting*

With Special Reference to the Inductive Processes

By J. J. JAKOSKY*

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IN THIS PAPER[1] I shall confine my discussion of the topic selected to a brief consideration of the fundamental factors underlying the operation of electrical methods for geophysical prospecting and geological subsurface investigations.

Electrical methods can be advantageously employed when the electrical conductivities of the different strata or components of the earth's surface differ considerably. As applied to the location of mineralizer areas or zones, the greater the difference in electrical conductivity between the mineralized area and the surrounding envelope (the earth), the more pronounced or definite is the effect upon the recording or detecting instruments. Generally speaking, it is necessary that the difference in conductivity be of the order of 1 to 100 or more. Ratios of 1 to 100 are quite common; and good mineralized areas (such as massive sulphide indications) often have ratios from 1 to 1,000 to 1 to 10,000 compared with the surrounding earth.

Ores which are amenable to electrical prospecting are, generally speaking, those which may be classed as electrical conductors, though, as will be shown later, the question of conductivity is a relative one. Such ores include pyrites, graphite, chalcopyrite, arsenopyrite, some anthracite coals, a few carboniferous shales, galena, pyrolusite, magnetite, and the metals.

Many ores occur in nature in such chemical form that they are electrically non-conductive. These include the majority of the oxides, carbonates, and silicates; and two common sulphides, stibnite and sphalerite. Such ores generally are not amenable to electrical prospecting unless associated with other ores which may be conductive.

In many districts the geologist or mining engineer knows from previous investigations that certain ores often occur associated with other ores. In this way, an indirect method is available for locating the pay ore, owing to the presence of a conducting ore having no special commercial value. Unless the geology and manner of ore occurrence of a district are well known, it is difficult to obtain an authoritative idea of the commercial values of the mineralized area. Generally speaking, electrical prospecting methods are of value only in locating mineralized areas. These usually contain ores of more than one mineral. To illustrate this point, consider a mineralized area consisting largely of zinc sulphide, a non-conductor, combined with a very small amount of iron pyrite or iron sulphide, a conductor. Owing to the presence of the pyrite, the mineralized area is amenable to electrical methods of prospecting. Unless quite close to the surface, the zinc sulphide would have no effect on the electrical readings, regardless of its mass or length. The electrical effect of such a body would depend upon the amount of pyrite present; the commercial value of the area would depend upon the zinc sulphide.

Factors Determining Effective Conductivity

It is true that no one single factor determines the electrical conductivity of an orebody. The electrical properties of an orebody, with special reference to their amenability to electromagnetic or alternating current methods, are really dependent upon its effective conductivity, which takes into account the following factors: (1) Type of mineralization, (2) effects of frequency, (3) relative conductivity, and (4) current distribution. The relative conductivity of the ore to the surrounding envelope is of great importance. If an ore occurred in an envelope having the same conductivity, its detection by electrical methods would be impossible. The absolute or unit conductivity of an ore must be considered in connection with its effective area and mass. For instance, it is quite common for an orebody of poor unit conductivity and large mass to manifest the same electrical effect on the detecting apparatus as one of high unit conductivity and small cross-sectional area. In other words, unit conductivity and geometrical shape or size together determine a conductivity factor which I

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[1]The information contained in this paper is largely the result of the early investigations conducted by the Radiore Company. Acknowledgment is made to Messrs. A. B. Menefee, B. M. Snyder, and H. E. Olund, officials of the company, for material assistance and helpful suggestions during the various investigations made in the past and now in progress; to E. H. Guilford, of the same company, for maps and field data; to the members of the company's field crews and experimental staff; and likewise to Dr. Dorsey H. Lyon, of the U. S. Bureau of Mines and of the department of metallurgical research of the University of Utah, for suggestions.

call the mass or total conductivity. In addition, the relative conductivity must be considered. An ore having a relative conductivity of, say, 100 in an envelope of a relative conductivity of 1, will behave electrically similar to another orebody having a relative conductivity of 1,000 in an envelope with a relative conductivity of 10. An ore located in wet or fair-conducting strata must have an electrical conductivity that is much greater than that of an ore located in a dry desert region, to give the same effect as the latter.

Frequency Effects

The unit electrical conductivity of an ore is also dependent upon the type of current flowing through it. In many ores, the unit conductivity for direct current is quite different from that for alternating current. Some ores, such as chalcopyrite and iron pyrite, when in the massive state, have practically the same conductivities for direct currents and alternating currents. Ores of certain structure, and disseminated ores, exhibit quite different properties toward direct and alternating current. Laboratory measurements on samples of disseminated ores will be published at a later date.

The disseminated ore referred to may be considered as composed of small electrically conducting particles distributed in a matrix. As a rule this matrix is calcite, quartz, and the like, and has a low electrical conductivity—that is, a high resistance. If two conducting particles or masses are separated from one another, an electrostatic capacity will exist between these two particles. This capacity will be dependent upon the following factors: the area of the particles, inversely as the distance they are separated, and the dielectric constant or specific inductive capacity of the separating medium (in the case of a disseminated ore, it would be the matrix material). A disseminated ore may therefore from an electrical point of view be considered as a resistance shunted by a number of very small capacities connected in series-multiple. This is illustrated in Fig. 1. The electrical reactance or opposition to current flow offered by a condenser may be expressed by the following equation:

$$X = \frac{1}{2\pi fC}$$

in which

X = reactance in ohms
f = frequency in cycles per second
C = capacity in farads.

It can therefore be seen that the reactance offered by a disseminated orebody to an alternating current will vary with its effective capacity and the frequency of the impressed current. The foregoing assumes no electrical conductivity for the matrix or gangue. Calcite, quartz, and other minerals which constitute the gangue for many ores become electrically conducting because of their moisture and impurities.

The actual electrical conductivity of an ore may be stated in an elementary or comparative way as dependent upon two factors—(1) the direct current conductivity and (2) the alternating current conductivity. Alternating current conductivity is the reciprocal of the impedance, a factor which is dependent on the physical or electrical constants of the circuit, in this case resistance (which is largely in the matrix) and the reactance due to capacities. It is the value of the impedance which limits the current flow for a given impressed emf. The following formula expresses the relationship of these quantities:

$$Z = \sqrt{R^2 + X^2 + K}(K')$$

in which
Z = impedance in ohms
R = resistance in ohms
X = reactance in ohms
K and K' = constants dependent upon current distribution and frequency.

For such a system of resistances and capacities as illustrated in Fig. 1, it is, of course, possible to figure the resultant impedance if all the values are known. Inasmuch as there is no method nor purpose in arriving at these values for an underground orebody, we may be contented with remarking that the resultant of resistances in parallel is less than the smallest resistor's value; that the resultant of capacities in parallel is the sum of the individual capacities. Thus we see again that the greater cross-sectional area will give a greater over-all conductivity because of lower resistance and higher capacity.

Returning to the question of frequency, we can see that the alternating-current conductivities are many times

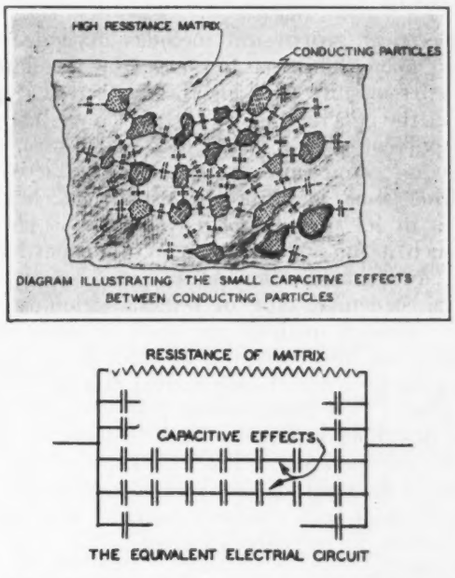

Fig. 1—Electrical effects in disseminated ores when subjected to alternating electromotive force

greater than the direct-current conductivity (remembering that conductivity is the reciprocal of impedance). Frequency of the impressed emf. must be considered in connection with the electrical conductivity of an ore.

Current Distribution

In a later part of this paper reasons showing that the effect upon geophysical indicating instruments depends considerably upon the distribution of current through the conductive orebody and the surrounding earth will be given. For instance, two separate conductors under certain conditions give an electrical effect similar to a single conductor situated somewhere between the two conductors. The distribution of current is dependent upon the relative conductivities of the various component paths through the orebody and the surrounding envelope, the effects of adjacent conductors, geometrical shape and mass of the orebody, and "skin effect." If a conductor

is of large cross-section or if the frequency is very high, the inner portions of the conductor carry only a relatively small portion of the total current. The density of the current is greatest at the surface of the conductor. At high frequencies and in large conductors the outer surface is carrying practically all of the current, and the central part of the conductor could be completely removed (leaving only the outer shell or "skin") without any noticeable change in resistance. The tendency of the current to concentrate at the outer surface of a conductor is called "skin effect." A more complete discussion of "skin effect" may be found in many textbooks.[2]

If there are other conductors carrying current in the neighborhood of the conductor under consideration (parallel orebodies, spurs, mineralized cross-fractures and the like) the distribution of current through the cross-section of the first conductor will be irregular. Often only the surface part of the conductor on one side is carrying an appreciable current. The higher the frequency, the greater are the effects attributable to redistribution of current.

Types of Electrical Geophysical Methods

All electrical geophysical methods depend for their operation upon the effects produced by the flow of an electric current. By studying these effects it is possible to predict the general axis of current flow. The greater flow of current will be in the path of greatest effective conductivity. And since the effective conductivity of a mineralized zone is different (usually much greater) than that of its surrounding envelope, it is possible to locate such a mineralized zone by the distribution of current, due consideration being given, of course, to geological structure, type of mineralization, and other factors. Various methods are used to cause this flow of current, and also numerous methods are available for detecting the presence of such current flow and for studying its effects. Of these various possible methods, three will be described briefly to illustrate the fundamental principles of operation. The information contained in this paper is the result of comparative field and laboratory investigations of such processes, together with studies of the literature. The statements made herein represent my own views.

Applied Potential Systems—In these systems a direct or alternating current is caused to flow through the earth by applying a potential difference between two electrodes placed on the surface or even extending some distance into the earth. One system of this type uses polar electrodes, usually 20 ft. in diameter and consisting of brass or copper pegs 2 or 3 ft. long driven into the earth. These electrodes are spaced one-quarter to half a mile apart, and the necessary direct emf. is applied to the electrodes to cause proper current flow to actuate the detecting or measuring instruments. The voltage necessary will vary, of course, with the conductivity of the terrain.

If the ground being studied is homogeneous, the current will be distributed according to known theoretical laws and the distribution may be calculated mathematically for polar conductors in a limitless homogeneous conductor. The equipotential or voltage drops about the electrodes in such a medium are usually distorted concentric circular curves. The curves are not true circles because the voltage drop is dependent upon current density. Current density on a line joining the two electrodes is greater of course than in other parts of the medium. A set of these curves is centered on each polar electrode, the dividing line between them being a straight line, where the curvature of one set passes into the other.

In the case where the earth is not homogeneous, the equipotential lines are not circles, and cannot be mathematically calculated. The field procedure now consists in locating and then plotting these distorted lines of equal potential, and, from past experience and proper correlation of geologic and tectonic conditions, predicting the location and extent of the conductive body. It must be so located in regard to the surface (considering sheet waters, relative conductivity of orebody and earth, and extent of orebody and depth below surface) that it will quite appreciably disturb or distort the flow of surface current between the two polar electrodes.

The surface distribution of the current is studied usually by means of two non-polarizing electrodes, a potentiometer, and a galvanometer. Each non-polarizing electrode consists of a porous earthen cup, in which a copper tube is cemented. This cup is then filled with a super-saturated copper-sulphate solution. At its upper end the copper tube fits into a brass sleeve. The whole electrode is about 5 ft. high. The brass sleeve is insulated at its upper end, and carries a reel of wire. One end of this wire is connected to one electrode, and the other end to one leg of the potentiometer. The potentiometer is mounted upon the other electrode and its second leg connected to this electrode. By means of suitable indicating instruments the potential difference between the two electrodes may be measured.

Another system of the same general type, in which the principles of operation are quite similar to those of the previous system, uses long parallel electrodes (usually bare wires and pegs) in place of the polar electrodes. The electrodes are often from 1,000 to 3,000 ft. long, parallel with each other and separated by 500 to 2,000 ft. In a homogeneous material, the current distribution is simple and flows in parallel paths perpendicular to and between the two electrodes. Equipotential lines are parallel to the two extended parallel electrodes. The presence of any material having a different conductivity may be indicated by a distortion of these equipotential lines. The system uses a low-frequency alternating current, and an audibility method using headphones and amplifier, in connection with a "searching coil" or electrodes, is employed to locate the points of equipotential (no signal), from which the equipotential curves may be plotted.

Self-Potential System—In this system advantage is taken of the flow of earth current due to galvanic or "battery" action occurring spontaneously within certain types of orebodies. These currents are produced by the chemical action of ground waters on the minerals present in the ore. Near the surface of the ground, the solutions present are usually oxidizing in character, and acid; at greater depths they become neutral or even reducing. The solutions act therefore as electrolytes of a galvanic cell. Natural electrodes and electrolytes are therefore present in the ground, and a current flows as a result of the difference in potential existing between different parts of the orebody. From near the apex of the vein, this current flows downward through the conducting orebody, and at a depth passes out into the country rock on either side, in which it flows back to the surface. The conducting body must extend in a continuous conductive

[2] Morecroft: "Principles of Radio Communication," page 113 et seq; Pierce: "Principles of Wireless Telegraphy," page 337 et seq; Zenneck: "Wireless Telegraphy," page 47 et seq.

mass between the upper ground-water electrolyte (acidic) and the lower electrolyte (neutral or reducing). The field technique consists in the observation and measurement of these galvanic currents, and the data thus collected must be interpreted in the light of geological evidence and experience.

Contact Method—In this method (exemplified by some of the so-called radio methods) one electrode is connected directly to the orebody, usually at an outcropping or by means of an insulated wire through a diamond-drill hole to a known orebody. The other electrode may be connected to the surface of the earth, or when high frequencies are employed (the usual case for the "radio" methods) connected to an open antenna. This method, where applicable, possesses advantages over the self- and applied potential methods in that a much greater current is obtained directly in the conductor itself. This process in its elementary form is of value largely in determining the extent of a known orebody, rather than for the initial discovery of such a body in an unknown territory or in reconnaissance surveying.

The Inductive Method—A considerable part of the remainder of this paper will be devoted to the main fundamentals underlying the operation of the electro-magnetic methods.

What Is the Best Method?

It is only natural that the query arises, which geophysical method is superior, and, in addition, which one of a particular method is the best? This question is as capable of a direct positive answer as, say, what is the best automobile or what is the best method of mining? No one process is the best under every condition. Certain processes are superior for working out general tectonic or geological conditions, whereas other processes would prove entirely unsuitable for such work, but would be ideal for other work where different conditions prevail. The best operating conditions for a process depend largely upon the fundamental principles of operation and the conditions pertaining in that particular locality where the process is to be used. Conditions most advantageous for one method may be incapable of an efficient or positive solution by another method. Even among similar electrical methods conditions will be found under which one process offers a better and more expedient solution than another process. This superiority may be due as much to design of apparatus and its adaptability to local conditions as to the principle of operation.

A territory covered with a heavy swamp or timber is quite different from a dry arid region. Flat, level country of uniform structure with very few watercourses is much easier to work with some processes than mountainous regions of broken terrain.

Fundamental Principles of Inductive Method

Electromagnetic Generation of an Emf.—The inductive method is so named because the current flowing in the conductor is obtained by electromagnetic induction, instead of by the use of ground electrodes, as in the applied potential systems just outlined, or by direct contact with the orebody. Whenever an alternating magnetic field cuts a conductor an emf. is generated. The magnitude of this generated emf. is a function of the strength of the magnetic field and the rate of change of the field; that is, its frequency. The higher the frequency, the greater the induced emf. This induced emf. will cause a current to flow, the magnitude of which will be dependent upon the effective conductivity of the conductor. The greater the conductivity, the greater the current flow.

In usual practice the magnetic field is obtained by causing an alternating current to flow in a closed coil or loop. Such a current flowing in a coil sets up an electromagnetic field having a frequency the same as that

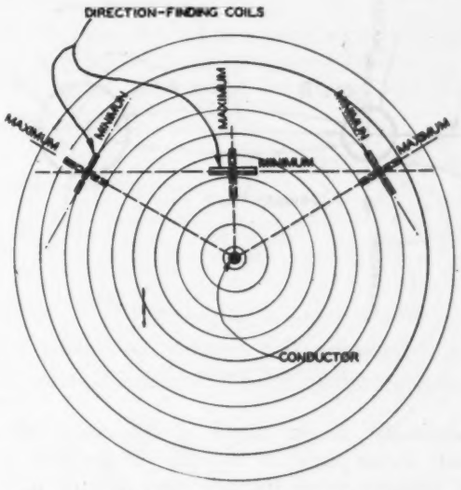

Fig. 2—Field surrounding a simple conductor in a homogeneous medium

of the alternating current. The current induced in the conductor will, of course, have the same frequency as the original current flowing in the energizing loop. Regardless of the alternating current employed—whether a so-called low frequency, say from 50 to 3,000 cycles per second, or the higher frequencies up to many thousands of cycles per second—practically the same fundamental phenomenon takes place.

Field Surrounding a Simple Conductor in a Homogeneous Medium—An alternating current flowing in a conductor sets up an alternating electromagnetic field having the same frequency as the current. In the case of a simple conductor, such as a small-diameter wire of great length suspended alone in air, the field will surround the wire and travel outward from it in the form of concentric circles or envelopes. These conditions are illustrated in Fig. 2. A direction-finding coil so pivoted that its axis of revolution is parallel to the conductor—i.e., axis of revolution of the coil and the conductor have the same "strike"—will give the maximum signal (having the maximum emf. generated in it) when the coil is perpendicular to a tangent to the circle of wave-front at that point. A minimum signal will be obtained when the coil is parallel to the tangent. This is depicted for three positions in the illustration. It can be seen that by the use of a direction-finding coil and simple triangulation, the position of the conductor can be determined.

Field Surrounding a Simple Coil Carrying an Alternating Current—As previously stated, alternating current flowing in a simple coil will create an electromagnetic field. This field will have the same frequency as the current, and will radiate or travel outward from the coil in closed magnetic or flux circles. These flux circles (in air or a homogeneous medium) will be perpendicular to the plane of the coil and will extend or travel outward with uniform velocity in every direction. Such a coil used for transmitting will exhibit similar figure-eight

characteristics to those exhibited by the direction-finding coil which will be described in detail later. Minimum field exists on the axis of the coil. This axis, of course,

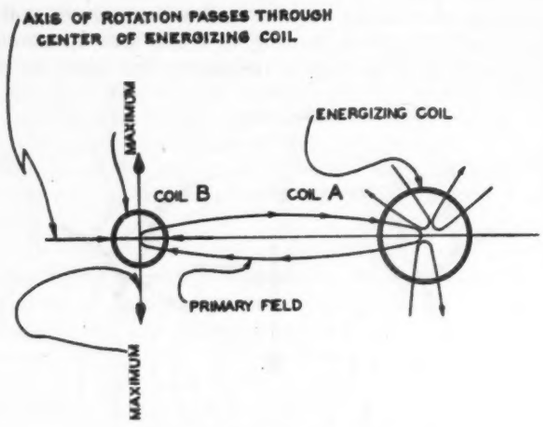

Fig. 3—Relationship between energizing and direction-finding coils

is perpendicular to the plane of the coil. Maximum field exists in the plane of the coil. If the field strength at equal distance from the coil were plotted in a plane of reference perpendicular to the plane of the coil and passing through the axis, a figure-eight curve would be obtained.

Detection of Secondary Field

The induced current flowing in the conductor (and the surrounding envelope if conducting) may be studied by a number of different methods. If desired, a system similar to that employed in the self- and applied potential methods may be used. Distribution of current at the surface may be studied by plotting equipotential lines. Indicating apparatus is different, of course, from that employed in the above-named systems, inasmuch as direct-current instruments cannot be used. The most satisfactory equipment that I have used for studying the surface distribution of an alternating current flowing in a conductor consists of a 1- to 3-stage completely shielded, constant-output, compensated amplifier connected to a sensitive galvanometer or to a potentiometer and headphone circuit. The amplifier can be used on any frequency by use of proper coupling transformers and devices. Input terminals are connected to ground electrodes and a procedure is followed similar to that previously described under the applied potential system. Such a system, of course, embodies the same disadvantages as the direct-current systems in requiring actual contact with the ground by use of electrodes. For certain work, this disadvantage may be overcome, however, by using medium frequencies and "capacity plates" instead of electrodes making actual contact with the ground. The capacity plates that I have used consist of sheets of wire netting (usually 2 by 10 ft.) laid on the ground or on the surface of the snow or ice. Owing to the electrostatic capacity between the plates and the earth, sufficient current flows to operate the amplifier and indicating apparatus. In a future article tests showing the effects of frequency for applied potential systems over orebodies of different characteristics can be described.

Direction Coil Method—The most satisfactory form of detecting equipment is that employing the direction-finding coil. By the use of such a coil the difficulties of obtaining good ground connections are overcome, especially when the ground surface is covered with heavy brush or moss, snow, and ice. Such a coil, with its associated apparatus, is easily portable and allows quick field manipulation. The complete apparatus consists of the direction-finding coil, an amplifier (for the audio frequency range), or a detecting and amplifier set, the output of which is usually connected to a pair of headphones.

Induced Emf. Dependent on Four Factors—The total voltage induced in a coil placed in an alternating magnetic field is proportional to the strength of the alternating field, its rate of change or frequency, the number of turns of wire in the coil, and the effective area of the coil. The effective area of the coil is used in this case to give an indication of the number of lines of force which pass through the coil when it is placed in a field of uniform intensity. The amount of flux linked with the coil is proportional to its area and the cosine of the angle between its direction and the direction of propagation of the lines of force.

Position of Coils for Maximum Signal Strength—If a direction-finding coil were placed as shown in Fig. 3, the maximum induced voltage (manifested by maximum signal strength) would be obtained when the coil is parallel with and in the same plane as the energizing coil. In this position the maximum number of lines of force will thread through the direction-finding coil, B. If the coil is rotated about a horizontal axis as shown, until it is perpendicular to the plane of the energizing coil, A, minimum signal strength will be obtained. It can thus be seen that a definite relationship exists between the angles of the two coils for positions of maximum and minimum signal strengths (assuming that the axis of rotation of Coil B lies in the plane of Coil A).

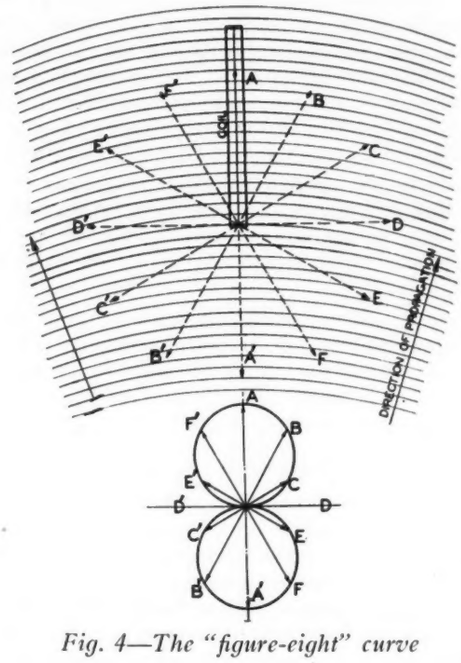

Fig. 4—The "figure-eight" curve

When the energizing coil is placed in a vertical position the direction-finding coil will give the maximum signal strength when vertical, and the minimum signal strength when in a horizontal position. This, of course,

holds true when the axis of rotation of the direction-finding coil lies in the plane of the energizing coil and intercepts its center.

The relationship between the energizing and the direction-finding coils just described will hold true when the two coils are in a homogeneous medium. If, however, a conductor were to exist in the vicinity of the coils, an induced current would flow in the conductor. This current would create another field which would also have its effect upon the direction-finding coil. When using such an energizing system for geophysical work, it is necessary that it be placed at some known angle, this angle usually being vertical or horizontal. In the absence of any disturbing factors, the direction-finding coil will always give a known angle depending upon the position chosen for A.

The "Figure-Eight" Curve—To arrive at the polar curve of a direction-finding coil it is simplest to regard the emf. as being a function of the flux linkage. In Fig. 4 is shown a plan view of such a coil in a uniform field. The axis of rotation of the coil is vertical. It can be seen that when the coil is in the position AA', perpendicular to the direction of the field, the maximum number of lines will link or pass through the coil. In this position the maximum voltage is induced in the coil. As the coil is rotated the number of lines linking the coil decrease, until at position DD' the coil is parallel to the direction of the field and no lines link it. In this position zero voltage is induced in the coil. The effective area of the coil may therefore be varied from the actual area when perpendicular to the direction of the field to zero when parallel with the field. If, say, 20 lines link the coil in position AA', we can calculate the number of lines linked at other positions. At B there will be 17.5, at C will be 10, and at D zero lines. If the rotation of the coil is continued we will have —10 at E, —17.5 at F, and —20 again at A'. The negative sign is used to denote a reversal of the generated emf., as inspection will show that the flux is passing through the coil in an opposite direction after position D or D' is passed. If the successive positions of the coil are drawn as vectors, and the length of the vector is taken to equal the number of lines of force linked with the coil in that particular position (the induced emf. being a function of the flux linkage), we will obtain the vectors shown in the lower part of the figure. Upon joining the ends of the vectors, two circles are obtained; one circle corresponds to the positive values of linkage as found above and the other to the negative values.

This diagram is known as the *cosine* or *figure-eight* diagram, and is characteristic of a simple coil when the dimensions of the coil are small compared to the wavelength.

"Sharpness" of Maxima and Minima—In practical direction-finding the accuracy with which a bearing can be taken depends to a large extent upon the sensitivity of the receiving apparatus to small changes in the direction of the coil. As is well known, the figure-eight diagram shown herewith is the basis of all radio and electromagnetic direction-finding systems. Readings might be made either by noting the position of the coil when signals are loudest or by observing the direction corresponding to the minimum signals. When the maximum strength is observed, the coil is in position OA or OA', and, as may be noted from the polar diagram, a small change in angle will make a relatively small change in signal strength. For instance, shifting the coil from OA to OB (an angle of 30 deg.) gives a relative change of $\frac{20.}{17.5}$. In the position OD or OD' a small change in angle will produce a very great change in relative signal strength. If the coil were rotated through the same angle of 30 deg. from OD to OE, the theoretical relative change would be $\frac{10}{0}$. (Note that $\frac{10}{0}$, numerically equal to infinity, does not mean infinite signal strength.)

The curve is therefore very steep around the minimum position, which means that the device will be far more

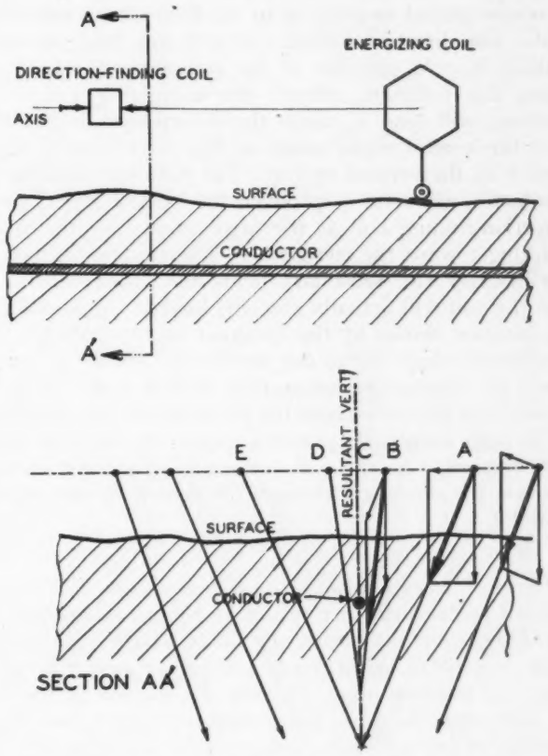

Fig. 5—Effects of primary and secondary fields

sensitive if adjusted for the zero signal instead of for the maximum signal. To this greater sensitivity of the directional properties of the coil is added the greater sensitivity of the average human ear in determining the existence or non-existence of a signal, rather than the maximum intensity of such a signal. If the readings are being made in a hard wind, or where disturbing noises are present, the operator will have difficulty in determining his minimum positions. In actual geophysical work, the minimum angles may be read accurately under average conditions to one-half degree for in-phase conditions. The question of phase relationship will be treated in a later paragraph.

For this reason the minimum point or direction is read in practice, but the direction usually recorded is that for maximum signal strength, which in a simple case would be 90 deg. from the position of minimum. If, for instance, the minimum signal was obtained at an angle of 65 deg. with the vertical, the point of maximum signal strength would be 90 deg. from that position or at —25 deg.

If two electromagnetic fields of the same frequency and in phase cut the direction-finding coil, the position of the coil for maximum or minimum signal strength will

be determined by the resultant of the two fields. If, for instance, one field is vertically polarized and the other wave is tilted so that it makes an angle of, say, 60 deg. with the horizontal, then the direction-finding coil, under proper conditions, will "point" somewhere between these two vectors, the exact direction depending upon the relative strengths of the two fields. If the fields were of equal strength, the resultant vector would lie equidistant between the two fields.

The elementary conditions prevailing in actual operation can best be illustrated by referring to Fig. 5. Here is pictured a conductor of considerable length and small diameter placed so as to be in the field of the energizing coil. The direction-finding coil will now have two fields linking it. At position *A* the component fields would exert the following effect: the energizing coil, being vertical, will tend to cause the direction-finding coil to give the loudest signal when it, too, is vertical as represented by the vertical vector. The field surrounding the conductor will tend to produce the loudest signal in the direction-finding coil at the angle shown by the vector pointing toward the conductor. The resultant effects of the primary and secondary fields are added vectorially, and the coil will actually give the loudest signal when in the position shown by the resultant vector. Moving the direction-finding coil to the position *C*, which is directly above the conductor, results in a vertical angle being obtained. At this point both the primary and the secondary fields will induce the loudest signal in the coil when it is vertical. As the coil is moved beyond the vertical position the dip angle changes, as shown by the vectors *D* and *E*.

(To be concluded)

In next week's issue Mr. Jakosky will discuss additional factors, such as effects of phase relationship between primary and secondary fields, relative magnitude of the two fields, distortion of wave front and of primary field, and phantom dips. He will also discuss the subject of indicated location of conductor and corrections thereto; of low vs. radio frequencies in coil systems; and the general field of application for the applied potential and the inductive methods.

New Cornelia Increases Ore Reserves

NEW CORNELIA is a relatively low-cost producer of copper with a long life indicated and extent of orebody not as yet fully defined, according to a study of the property by the *Wall Street Journal*. Recent drilling has shown much of the ore at Ajo to extend to a depth of 700 ft. instead of 600 ft., as was formerly assumed. This new drilling has occurred mostly since the last publishing of ore reserves. However, it is safe to say that as a result New Cornelia has well over 60,000,000 tons of ore developed, averaging around 1.2 per cent copper, with a considerable further tonnage indicated.

The writer of the article mentioned goes on to state that New Cornelia is producing around 75,000,000 lb. of copper a year at a cost somewhat under 9c. a pound, including depreciation, and could with slight additions to the flotation plant produce 100,000,000 lb. of copper a year with appreciable reduction in cost. About 20 per cent of the present output is coming from the oxidized or leaching ore, and the rest from the disseminated sulphide ore. The oxidized ore will last about two years longer at the present rate of mining.

Decomposition of Refractory Brick in a Copper Reverberatory Furnace

WITH the introduction of powdered coal and oil for the firing of copper reverberatory furnaces some years ago, a new era was begun in smelting practice. In recent years, notable increases have been made in the capacities of furnaces and in the amount of fuel necessary to smelt a unit of charge. Many phases of the improved practice are described by G. L. Oldright and F. W. Schroeder in A.I.M.E. Technical Publication No. 49. A limiting factor in the degree of heat attainable has been the refractory quality of the silica brick used in the roof arch of the furnace, so the authors of this paper made a study of this subject, investigating the action of the dust of the charge on the hot brick.

In the conclusions it is pointed out that the fluxing action in general may be summarized as follows: The pore space of the brick draws up the fusible silicates by capillarity, and the slag, formed by the union of the basic dust and acid brick, enters to a distance determined by its fluidity, which is in turn governed by the temperature. Where the fluxing is not too rapid, zones appear in the brick. On the bringing up of fresh basic dust, the silica content, particularly of the finer sized binder, becomes sufficiently lowered for the bottom part of the brick to become fusible and for droplets to appear in the hot zone where the action is very rapid. These drips contain fragments of silica altered only by heat treatment.

"The maximum practical temperature of operation of the furnace is determined by the point at which the silicates made by the dust in contact with the roof become easily fusible. The temperature where the drips from the hot zone of one furnace fused was 2,600 deg. F. (about 1,430 deg. C.). It was also noted that coarse uncombined particles of silica will even slough off. The lessening of dusting will decrease the speed of corrosion of the brick at a given temperature. The extent to which the dusting must be reduced before an attempt may be made to increase the temperature, and thereby the capacity markedly, is another very important point upon which data are lacking, and results may only be conjectured. Unless the dusting were nearly eliminated, there would be the same phenomena of slag penetration of the brick and lowering of its fusion point. As the temperature is increased, the base requires more silica to 'satisfy itself,' and after the binder goes, large unfused lumps of silica may form the drips. The length of increase in life of refractories on a diminution of the amount of dusting at the present smelting temperature cannot be used, then, as a basis for computing the increased length of life of brick under conditions when the dusting is likewise decreased but the temperature is raised.

"Judging from the experimental results of steel open-hearth practice, cooling the silica brick with water jackets would not greatly lengthen their life. The effectiveness of water-cooling with refractories of higher heat conductivity (such as magnesite) would probably depend on the intimacy of contact between the water jacket and the refractory.

"From the historical development of the reverberatory it would seem that the best chance of improving present practice lies along the line of still higher temperatures in the hot zone and that a refractory of better quality is necessary before this temperature can be increased much further."

World's Developed Water Power Over 33,000,000 Hp.

THE developed water power of the world, according to estimates made by the U. S. Department of the Interior through the Geological Survey, was about 23,000,000 horsepower in 1920, 29,000,000 horsepower at the end of 1923, and 33,000,000 horsepower at the end of 1926, an increase of 43 per cent in six years. About three-fourths of the increase for the last three years has been in the English-speaking section of North America. Europe made a brief spurt during and after the World War, but has now slowed down appreciably in its construction of hydro-electric power plants. Canada is the only country that approaches the United States either in the size of constructed plants or in the rate at which development is taking place. Italy and Switzerland are still making considerable progress in building new plants, and Sweden and Norway have a slow, steady growth. France and Germany are depending more on steam plants. No recent figures are available for Japan, but it is presumed that plants already undertaken are gradually being completed.

It is difficult to co-ordinate estimates of water power for the several countries, particularly estimates of potential water power, because of differences in their elements and character and in the completeness and accuracy of the data on which they are based; but the estimates here given are considered sufficiently accurate to afford a rough idea of the potential water-power resources of the world and the extent of their development. The figures for the developed water power represent the rated capacity of water wheels or turbines installed, and the figures for the potential power represent the total power that could be obtained at ordinary low water, including the power already developed.

In the following table the figures showing the potential power for the United States represent the power available 90 per cent of the time at 70 per cent efficiency:

Summary of Potential and Developed Water Power in 1926, in Horsepower

North America

	Developed	Potential
Mexico	300,000	6,000,000
United States	11,721,000	35,000,000
Alaska	43,000	1,000,000
Newfoundland	160,000	400,000
Canada	4,556,000	18,250,000
Costa Rica	15,000	1,000,000
Guatemala	4,000	1,500,000
Honduras	3,000	1,000,000
Nicaragua	400	800,000
Salvador	2,700	200,000
Panama	13,300	500,000
West Indies	19,350	150,000
Approximate totals	16,800,000	66,000,000

South America

Argentina	25,000	5,000,000
Bolivia	13,500	2,500,000
Brasil	500,000	25,000,000
British Guiana	.....	2,500,000
Dutch Guiana	.....	800,000
French Guiana	.....	500,000
Chile	114,000	2,500,000
Colombia	25,000	4,000,000
Ecuador	5,500	1,000,000
Paraguay	200	2,000,000
Peru	55,000	4,500,000
Uruguay	.....	300,000
Venezuela	13,000	3,000,000
Approximate totals	750,000	54,000,000

Europe

	Developed	Potentia
Sweden	1,350,000	8,000,000
Norway	1,900,000	9,500,000
Finland	220,000	1,800,000
Russia	230,000	3,000,000
Estonia	16,950	125,000
Latvia, Lithuania	5,000	100,000
Poland	90,000	1,400,000
Ukraine	40,000	425,000
Region of the Caucasus	5,000	5,000,000
Hungary	3,000	175,000
Czechoslovakia	155,000	1,000,000
Yugoslavia	180,000	3,000,000
Austria	325,000	1,660,000
Rumania	30,000	1,600,000
Bulgaria	18,000	1,200,000
Greece	8,000	250,000
Turkey	.....	Small
Albania	1,000	500,000
Italy	2,300,000	3,800,000
Switzerland	1,850,000	2,500,000
Germany	1,100,000	2,000,000
France	2,000,000	5,400,000
British Isles	250,000	850,000
Belgium	700	Small
Denmark	11,000	9,000
Netherlands	150	Small
Spain	1,000,000	4,000,000
Portugal	10,000	300,000
Iceland	.....	500,000
Approximate totals	13,100,000	58,000,000

Asia

Chinese Republic	1,650	20,000,000
India	200,000	27,000,000
Asia Minor	500	500,000
Arabia	.....	.....
Persia	.....	200,000
Afghanistan	2,000	500,000
Siberia	90,800	8,000,000
French Indo-China	.....	4,000,000
Siam and Malay States	4,500	4,000,000
Chosen	18,300	500,000
Japan	1,750,000	4,500,000
	2,100,000	69,000,000

Africa

Tangier	.....	50,000
Morocco	.....	250,000
Algeria	130	200,000
Tunisia	.....	30,000
Tripoli	.....	Small
Eritrea	.....	Small
British Somali	.....	Small
Italian Somali	.....	Small
Gold Coast and British mandate in Togo	.....	1,450,000
Liberia	.....	4,000,000
Sierra Leone	.....	1,700,000
Senegal	.....	250,000
Rio de Oro	.....	Small
Gambia	.....	Small
Portuguese Guinea	.....	Small
Union of South Africa	5,000	1,600,000
Angola	4,000	4,000,000
Southwest Africa (Union of South Africa mandate)	.....	150,000
Belgian Congo and Belgian mandate	250	90,000,000
French Congo	.....	35,000,000
French mandate in Cameroon	.....	13,000,000
Nigeria and British mandate in Cameroon	.....	9,000,000
Rhodesia	2,500	2,500,000
Tanganyika (British mandate)	800	2,700,000
British Central Africa	.....	1,200,000
British East Africa	900	4,700,000
Portuguese East Africa	.....	3,700,000
Bechuanaland	.....	20,000
Abyssinia	.....	4,000,000
Egypt	.....	600,000
Ivory Coast, Dahomey, and French mandate in Togo	.....	2,850,000
French Guinea	.....	2,000,000
French Sudan	.....	1,000,000
Madagascar	100	5,000,000
Approximate totals	14,000	190,000,000

Oceanica

Australia	2,000	600,000
New Zealand	60,000	2,500,000
Philippine Islands	.....	1,500,000
Sumatra	20,000	2,000,000
Java	60,000	750,000
Borneo, including New Guinea and Papua	.....	7,500,000
Tasmania	75,000	700,000
Celebes	500	1,000,000
Hawaii	25,000	100,000
Approximate totals	240,000	17,000,000

Recapitulation

North America	16,800,000	66,000,000
South America	750,000	54,000,000
Europe	13,100,000	58,000,000
Asia	2,100,000	69,000,000
Africa	14,000	190,000,000
Oceanica	240,000	17,000,000
Approximate totals	33,000,000	454,000,000

Crushing Rolls for Ore and Stone—*

Their Development

By W. T. W. MILLER

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THE introduction of crushing rolls into the service of the mining engineer dates back about one hundred and twenty years, and during that period a great variety of machines have been developed, all embodying the roller principle but differing widely in details of construction. It is probable that the infinite diversity of sizes and types in general use arises in large measure from the fact that rolls may be employed for many purposes, each calling for special features in design. The machine which is perfectly satisfactory for a certain duty may be entirely unsuitable for another kind of work, and the best judgment and experience of engineer and manufacturer are needed to decide on the particular type for any specified purpose.

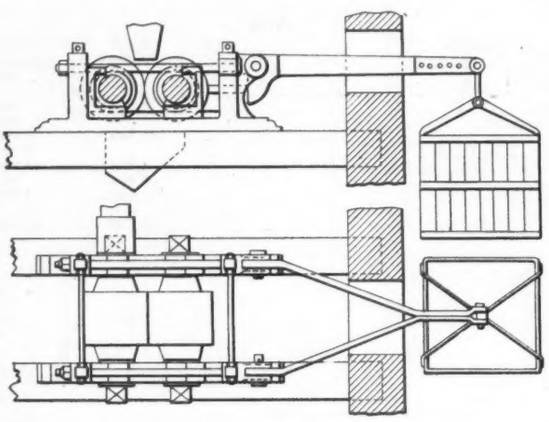

Fig. 1—An early set of rolls after the Cornish style. These rolls were usually 18 to 30 in. in diameter and 14 to 20 in. wide

During their long history crushing rolls have waxed and waned in popularity. From time to time they have been displaced in certain fields by machines of other types, but, after falling temporarily under a cloud, they have usually reappeared in some improved form to strengthen the claims made by their advocates and to confound their opponents. Recent developments in the practice of ore-dressing prove this statement to be warranted, as the increase in size and power of the roller crushers has been little short of phenomenal.

It is always interesting to follow the various steps in the evolution of a machine from its primitive origin to its more elaborate and serviceable descendant, and few family histories in the mechanical world can compare in this respect with the story of the rolls.

Records show that crushing rolls were introduced at the mines in Cornwall about 1806. The machines proved so successful that they became widely used, and the pattern was named for the county, so that the title "Cornish rolls" was accepted for many years as defining this particular type.

Fig. 1 illustrates an early machine after the Cornish style. The rolls were usually 18 to 30 in. diameter and from 14 to 20 in. wide. They were driven at speeds varying between five and fifteen revolutions per minute, the motive power being frequently obtained from a waterwheel.

The rolls were mounted on heavy shafts revolving in open bearings which were contained within strong cast-iron side frames. The bearing blocks were held down on the slides by square section rods, which served also to reinforce the end columns on the frames. One of the rolls was positively driven through coupling boxes and the other was usually revolved by frictional contact with the positive roll.

To insure the rotation of the idler roll, and at the same time to act as a safety device to protect the machine against overstrain, a heavy double bell-crank lever, in the form of a gigantic tuning fork, was hinged to the roll frames in such a manner that the short ends of the lever contacted through pressure pins with the bearings

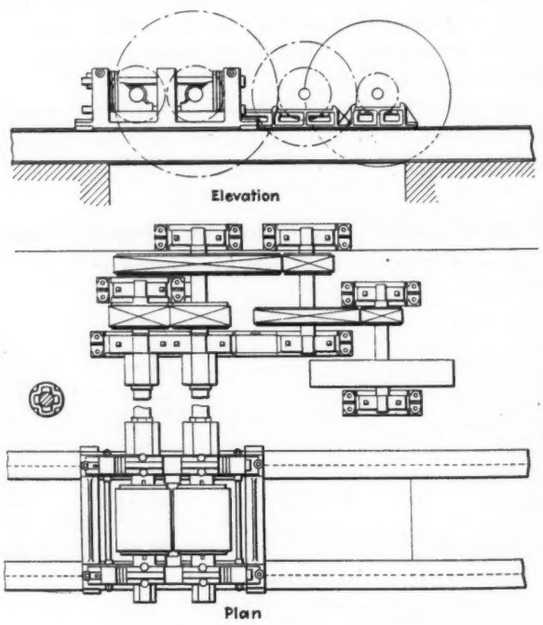

Fig. 2—A set of rolls built for a granite quarry in the Channel Islands about 1900

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for the free roll, which were self-adjusting in the side-frames.

The outermost extremities of the levers were bolted together and a box containing ore or pig metal was suspended from the end, the leverage ratio being nine or ten to one and the weight a variable quantity to suit the class of ore being crushed, the total pressure at the roll faces varying from 3 to 10 tons.

This Old Type Still in Use

It may be thought that machines of this antiquated type have long been discarded in favor of more modern high-speed rolls. I am able to record, however, that four mills, of the old Cornish pattern with some refinements in detail, were ordered as recently as 1919 by one of the largest companies handling Spanish pyrites ore. The particular service which these rolls were called upon to perform was to crush the burnt ore, after the extraction of the sulphur, from a maximum of 2½-in. cubes

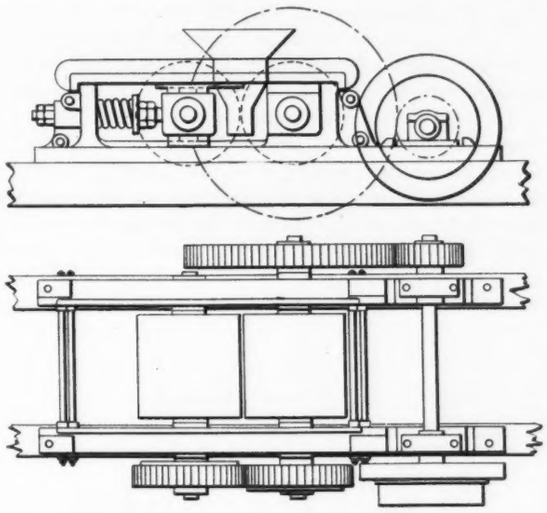


Fig. 3—A simple form of geared rolls for intermediate crushing

down to such a size that it would pass a slotted wire opening one-ninth of an inch wide. This firm had used the old-fashioned rolls for this purpose, and had also erected a plant for the same duty using high-speed belt-driven rolls. In the latter operation it was found necessary to reduce the ore in two stages, whereas the slower rolls made the reduction in a single machine.

The rolls were made of hard cast-iron and were 30 in. in diameter, 36 in. wide, one roll of each pair being positively driven at 21 r.p.m., the other being made to contact by means of the balance weight and bell-crank levers, and so friction driven. The total pressure at the roll faces varied from ten to twelve tons. Although the smooth faces of the rolls wear unevenly toward the end of their life, they register very closely, and the regularity of the product is well maintained.

Except for the belt-and-gear drive from the electric motor, these mills followed the older construction in all respects, and they continue to give satisfaction to the company, the officials of which are convinced that, for this particular duty, they are more serviceable than high-speed narrow-face rolls.

When machinery was introduced into the roadstone quarries, about forty years ago, to displace hand labor in preparing macadam, the jaw crusher was used for

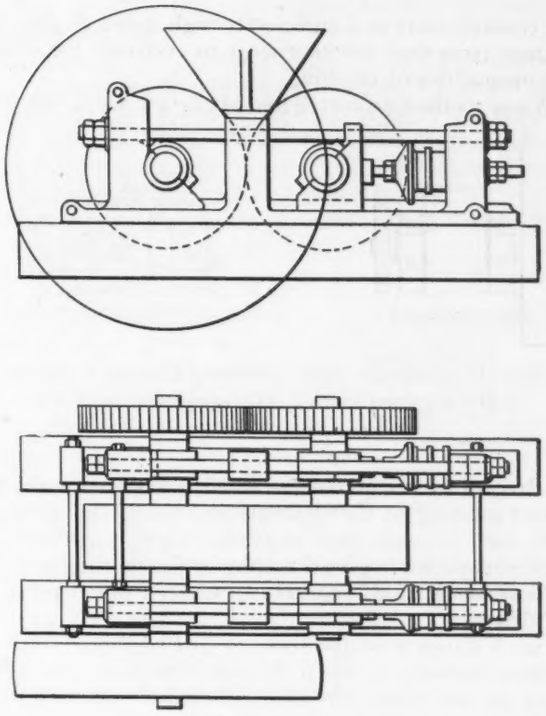


Fig. 4—An early example of moderately high-speed rolls for fine crushing

coarse crushing and heavy slow-moving rolls were adopted in some of the larger quarries for finishing the stone. Machines of this type are in use for this purpose in several parts of Great Britain at present. An examination of Fig. 2 shows that the design of these rolls was based on machines then used in the mining industry. The mill illustrated was built for a granite quarry in the Channel Islands about 1900. The rolls were 33 in. in diameter and 36 in. long, both being positively driven through "wobbler-boxes" and short "wobbler" shafts coupled to a train of heavy gears.

The roll frames and shafts were of cast steel, and the bearings were adjusted, to alter the setting, by inserting or removing packing shims between the frame pillars and the bearing blocks. Manganese steel roll-shells, having checker-board teeth with rounded tops, were fitted to these rolls with the intention of repeating by mechanical means the action of hand hammers knapping the stone.

Used in the preparation of granite macadam these rolls, running at 16 r.p.m., were fed with slabby pieces, averaging 5x4x3½ in., reducing these to pass a 2½-in. mesh at the rate of 40 to 50 tons per hour. Owing to the heavy nature of the work, no springs or safety levers were used, but the machine was built to resist the high tensional strains and has satisfactorily withstood the shocks for twenty-five years.

Gear Drive Usual in Early Days

Driving the rolls through gearing was almost universal in the early stages of their history, and this system is by no means obsolete. For slow-moving rolls of relatively small diameter the extra purchase obtained by the primary gear reduction is a great help in preventing the rolls from "stalling" caused by irregularities in feeding. By means of gearing it is possible to run the rolls slowly, yet, at the same time, revolve the flywheel and pulley on

the counter-shaft at a sufficiently high speed to gain advantage from their kinetic energy to overcome the shocks and inequalities of crushing.

When toothed or corrugated shells are used, the rolls

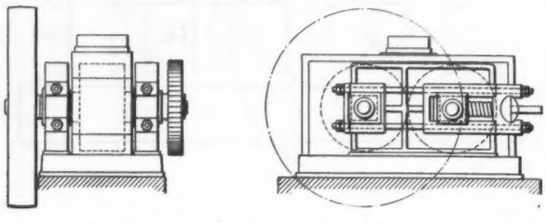


Fig. 5—Rolls for light crushing having a single belt-pulley with equal involute gears coupling the rolls

are frequently connected by equal gears to insure the correct meshing of corrugations and spaces on opposing rolls, and, in some rare instances where a differential speed is required to give a tearing action on the material, the positive rotation by gears is preferred to independent belt drives.

Fig. 3 shows a simple form of geared mill for intermediate crushing in which the side frames are extended to act as sole plates for the countershaft bearings and the main gears are placed on one side of the framework and the connecting gears on the other. The speed of the countershaft is about four or five times greater than that of the rolls. In a machine of this pattern the rolls are usually made of a width approximately equal to their diameter, which varies from 20 to 30 in. Spiral or involute springs are fitted between the adjustable bearings and the end posts, and the frame caps are notched to act as tension members for the upper portions of the framework. Although they are tied together by simple cross-stays, the alignment of the frames depends largely on the rigidity of the substructure or foundations.

When rolls are used for finer crushing it is necessary to run them faster to obtain any reasonable output. Under these conditions the countershaft with purchase gearing would be revolving at excessive speed, and as the enhanced velocity increases the kinetic energy in the rolls, which may be augmented by fitting heavy belt-pulley directly on the roll shaft, the drive may be simplified by the elimination of the primary gearing.

An Early Example of High-Speed Rolls

The machine illustrated in Fig. 4 is an early example of moderately high-speed rolls for fine crushing. The more arduous nature of the work increased the pressure on the bearings, and the makers quickly realized that the rolls must be reduced in width to work satisfactorily; hence, the proportion of face to diameter was changed to about one to two.

The frame was designed on similar lines to the machines already described, and the springs took the form of rubber buffers made of rubber and iron washers alternating. One roll shaft was extended to carry a heavy belt-pulley and a gear wheel, the other shaft bearing the second gear wheel. It will be noted that a single longitudinal tie rod was fitted in the upper part of each side frame in place of the joggled cap as a means of strengthening the framework.

Although operating in a similar manner to the machine just described, the rolls shown in Fig. 5 are of more modern construction, the design being favored for light crushing work in several European countries. The system of single belt-pulley with equal involute gears coupling the two rolls is identical with that shown in Fig. 4, but the frames and bearings are differently arranged. In this instance the sides are bolted to a substantial bedplate, the working parts are covered by a mild steel dust-housing, and the bearings are so mounted that the rolls are withdrawn endways instead of being lifted vertically. This disposition of the bearings makes it possible to utilize the long through tie-bolts top and bottom which entirely relieve the side frames from tensional strains.

In the machine illustrated an additional safety device is included between the springs and the rear frame caps. This takes the form of collapsible cover-plates, a feature of doubtful merit.

The surfaces of rolls are subjected to wear and their diameters change in the process of time, making it necessary that, in direct-connected rolls, the gear wheels should be capable of working at variable centers. It is rarely possible, however, to provide involute teeth of adequate length to admit of sufficient adjustment to wear out the shells completely; spare wheels of smaller diameter have to be fitted to overcome this difficulty.

The "wobbler" drive, shown in Fig. 2, was designed to avoid the use of change gears; the coupling boxes were made a loose fit over the driving ends of the shafts and allowed sufficient play to permit the connecting shafts to revolve freely at a slight angle of departure from the

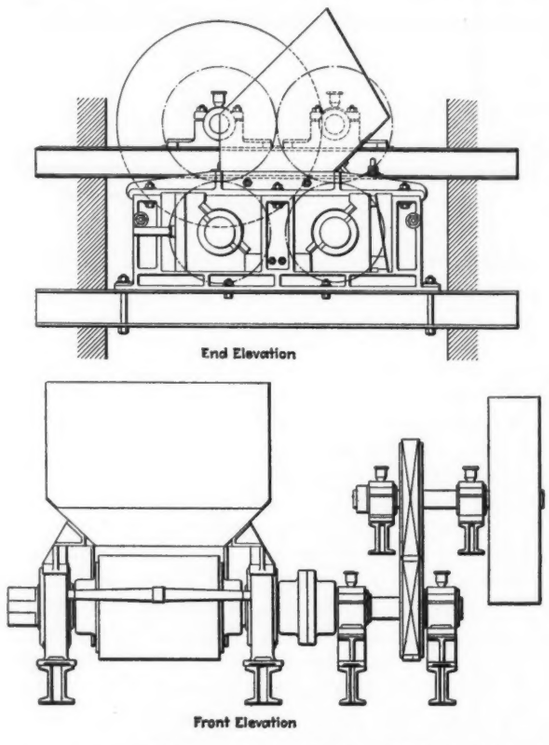


Fig. 6—A gear-driven set of rolls in which provision has been made for adjustment of working centers

true center line, so that the relative positions of the rolls could be changed within reasonable limits.

Fig. 6 illustrates a gear-driven mill in which provision is made for considerable adjustment of the working centers by a special arrangement of the gear wheels. This set of rolls was built about twenty-five years ago to

crush iron ore to approximately 6-in. size for the blast furnaces. The rolls were 37 in. in diameter by 42 in. long, and of cast steel, the side-frames being made from the same material. Roll shells had stout conical teeth, spaced some distance apart, as it was desired to make a minimum amount of fines.

The train of gears included four wheels arranged in two pairs. The lower pair were attached to the roll shafts, but did not mesh together; the upper pair, of slightly larger diameter, were fitted to separate countershafts and connected to each other. Each of the lower wheels interlocking with one of the upper was free to move sideways to a considerable distance before the involute teeth came out of gear.

It will be noted that, with a countershaft speed of 172 r.p.m., the rolls were running at 200 r.p.m., so that the

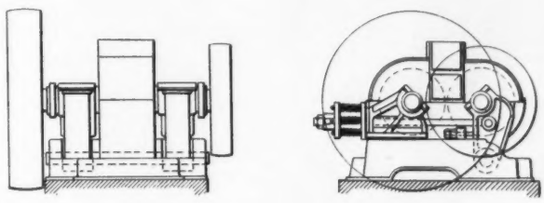


Fig. 7—Double belt-pulley rolls devised by Krom for medium-fine crushing

gearing was not used for mechanical advantage but to meet the exigencies of the situation which rendered a single belt-drive necessary.

Double Belt Pulleys Used

The complication of the gear drive and the heavy wear and tear incidental thereto led to the adoption of the double belt pulleys for all but slow-moving rolls. Krom was a pioneer in this system of driving crushing rolls, and the machine shown in Fig. 7 was recommended by him for the work of medium-fine crushing.

Bearings for the fixed roll were bolted to a deep bedplate and those for the adjustable roll formed part of two rocking-lever arms hinged to the underframe and also connected by strong tie-bolts to spring batteries that were buttressed on extensions of the rigid bearings.

Spacing between the rolls was adjusted by means of setscrews pressing against the swinging pillow-blocks, and the situation of the tie-rods below the roll shafts made it possible to lift the rolls and gain access to the bearings without uncoupling the rods. The position of the rods, however, was not ideal from the mechanical point of view.

Reliance rolls, illustrated in Fig. 8, were generally similar to the Krom machine, except that the tie-bolts were placed above the bearings, a more effective position for leverage but more troublesome when roll or bearings had to be changed. The roll setting was altered by unscrewing the lock-nuts on the tie-rods and readjusting the springs, and though this was in some respects an improvement as compared with the pinching screws, any slackness in the pins connecting the rods to the lever arms was a source of chattering that eventually proved destructive.

As years went on the increasing size of mining and crushing plants created a demand for more robust machines to cope with the heavier duty, and attempts were made to simplify the construction for the purpose of attaining this end.

Although not in chronological order in the series now under discussion, the mill shown in Fig. 9 may be cited as an example in which the number of parts was reduced to a minimum. C. G. Buchanan manufactured rolls of this type for a number of years. The frame was made in one piece of cast iron or semi-steel and the spring batteries and bearings were contained within the bedplate.

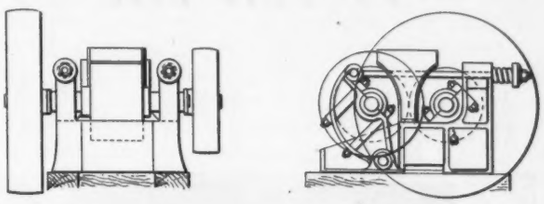


Fig. 8—Rolls similar to those shown in Fig. 7 but with the tie bolts placed above the bearings

Heavy caps with overhanging lugs were clamped to the framework to retain the bearings and reinforce the structure.

A Device to Make Rolls Turn at Equal Speeds

One feature of similarity in regard to these belt-driven rolls which requires some explanation is the very general practice of fitting one roll with a large pulley and the other with a pulley of much smaller dimensions. To the uninitiated this appears to be evidence that the rolls are intended to revolve at different speeds, but this type of drive is actually adopted to insure both rolls rotating at equal speed. Advocates of this system claim that the rolls are not always equal in diameter, that pulley sizes are rarely strictly accurate, and that belt-slip will vary in any two belts, with the result that rolls which were intended to run at equal speeds may have different circumferential velocities, causing excessive wear on the shells. To overcome this difficulty a large pulley, capable of transmitting the whole of the power required by the rolls, is keyed on the fixed-roll shaft, and the pulley on the movable roll is made of sufficient size to keep this roll revolving in the intervals between crushing. The rolls are driven at nominally equal speeds, and, should

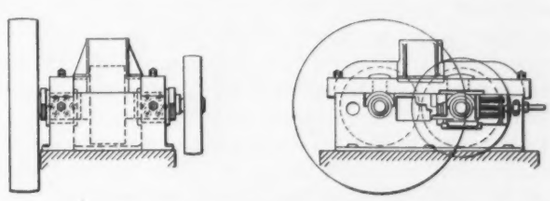


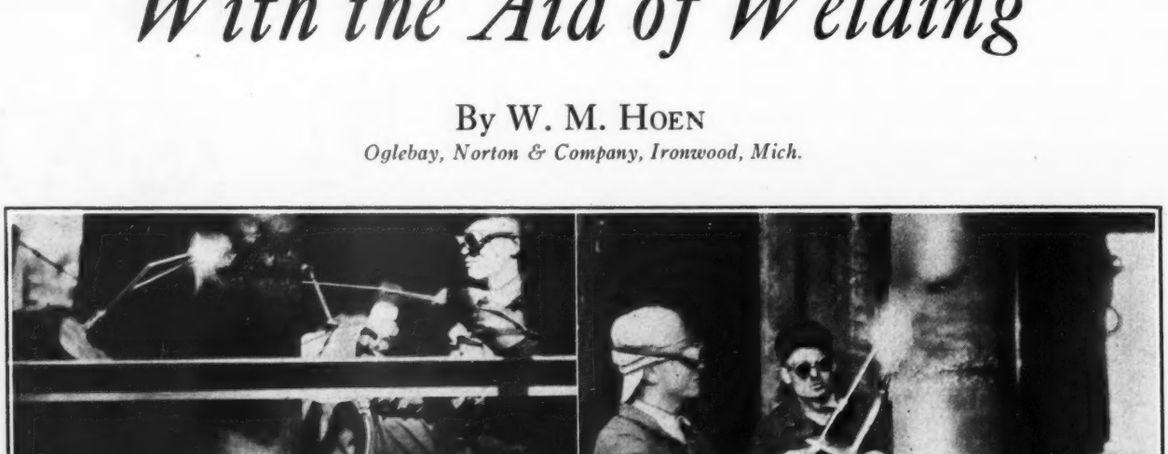
Fig. 9—An example of a set of rolls in which the number of parts is reduced to a minimum

any differential movement arise, the tractive effort of the large pulley transmitted by friction through the material to the movable roll is sufficient to overcome all irregularities and maintain equal velocities. As will be seen from later illustrations, this system is not universally adopted, and there are several factors which must be taken into account before deciding on the most suitable drive for any roller crusher.

(To be continued)

Installing a Pipe Column With the Aid of Welding

By W. M. HOEN
Oglebay, Norton & Company, Ironwood, Mich.



Left, making a 10-in. vertical weld, using two torches. Right, finishing the weld with one torch

EARLY IN 1927 the Montreal Mining Company, at Hurley, Wis., on the Gogebic iron range, found it advisable to install a central pumping plant at its No. 5 shaft. The pump station is installed on the 27 level, 440 ft. below sea level, and the collar of the shaft is 1,575 ft. above sea level. The shaft is a vertical five-compartment shaft sunk in greenstone and "timbered" with steel sets. Part of it is incased with concrete lath flush with the inside of the steel members. One compartment is reserved for pipes and cables. A 10-in. water column was the smallest that would meet the estimated pumping requirements economically.

Various methods of joining the sections of pipe have been used in installing water columns in deep shafts. In such shafts the pipe has usually consisted of flanged couplings. For high-pressure work these flanges were of standardized design and were available in forged and cast steel for unusually high pressures. The flanges might have differed in details of design, but were alike in that they were all held together by suitable bolts with gaskets between. The flange joints were inconvenient, as they took up much room in a place where space was limited, and because of their size, especially on extra-high-pressure pipe, were likely to be damaged by skip derailments or falling rock. These disadvantages led to the adoption of the welded joint, which in several years of service in oil pipe-line work has proved that it will last as long as the pipe. This was the ideal type of joint. The problem was to adapt it to the peculiar conditions found in a vertical shaft where mining operations must be maintained.

Sunday was selected for installing the line, because no regular hoisting was done on that day. Although the pipe compartment is screened off from the skip compartment, safety rules did not permit work to be done in the shaft while hoisting was in progress. Installing a pipe with flanges would have been a simple, even though tedious, process, as several sections could be installed each week end.

No previous experience in welding under such conditions was available. Owing to the limited period in which work could be carried on, it was decided not to do any welding in the shaft, but to weld the pipe in sections with flanges at the end of each section and lower one long section into place. The design of the pipe column, as finally worked out, provided that each pipe section should be approximately 100 ft. long and that it should be flanged and all intermediate joints welded.

To meet the pressure requirements for the depth of this shaft (the probability of a long life for the mine being also taken into account), the water column was designed to be made up of three different weights of pipe. In addition to the static pressure, allowance was made for shock; heavier pipe was used, moreover, on account of the desire for long life of the equipment and safety against pipe failure.

Preparations for sinking the main shaft below the 27 level were under way, so it was necessary to start the water column at a point 63 ft. above that level. A suitable footing was designed to support the entire column load. This consisted of fabricated steel beams and bars placed in an excavation in the greenstone rock at the side of the shaft, which excavation was then filled with concrete. The actual footing projected from this mass of steel and concrete into the pipe compartment and was designed to support a total load of 300,000 lb. A special extra-heavy cast-steel base elbow was set on this support, and from this point the water column was assembled vertically. Every 40-ft. section of the pipe was clamped to the wall plates. Alternate 40-ft. sections were also equipped with a pipe-supporting clamp resting on the cross members of the shaft sets. These supports were provided so that future repairs might be made quickly and safely.

The pipe column is divided into three main sections, according to the weight of pipe used, the three weights being, respectively, hydraulic, extra heavy, and heavy standard. The first 460 ft. of pipe extending upward from the base elbow consists of 10-in. hydraulic black steel pipe with a $\frac{3}{4}$-in. wall. This is divided into five flanged sections, three of which are 100 ft. and two 80 ft. long. The second main section consists of 900 ft. of 10-in. extra-heavy pipe divided into nine flanged sections. The third main section, the uppermost of the line, consists of 600 ft. of 10-in. standard, 41-lb. pipe which is divided into approximately 100-ft. sections.

Flanges, where used, are of the forged-steel type and conform to American standards for 900-lb., 600-lb. and 400-lb. steam working pressure, according to the section of the pipe line. All flanges are held together by chrome-nickel-steel bolts using a thin fiber gasket. The flanges are of the raised face type, screwed on the pipe, faced off and back-welded.

Ten-inch hydraulic pipe is available only in 20-ft. lengths. Extra heavy and standard pipe is manufactured in 40-ft. sections, but could not be obtained in this length in time to meet the requirements of the work, so all pipe was purchased in approximately 20-ft. lengths. The pipe was ordered with a half-inch bevel, leaving $\frac{1}{16}$ in. of the pipe on the end not beveled, except the end sections, which were equipped with flanges.

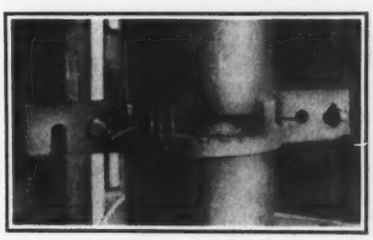
The steel headframe at the collar of the shaft is built so that a 40-ft. length of pipe is the longest that can be placed into the pipe compartment. The 20-ft. sections were therefore assembled on skids and the 40-ft. sections made by means of horizontal welds. This class of welding is standard practice and no unusual difficulties were experienced in doing the work, even with the heavy hydraulic pipe.

For vertical welding a special clamp was designed as a support for the line. It was placed over the pipe compartment. A small auxiliary hoist in conjunction with the mine skip hoist was used to lower the pipe. The first 40-ft. section (flanged at the lower end) was placed in a vertical position and held at the collar of the shaft by means of a clamp, with the end of the pipe a few feet above the collar. A second 40-ft. section was then hoisted and held in position by means of the hoisting rope and a special clamp which held the ends of the two sections in alignment for welding. The vertical weld was then made. After a short time for partial cooling had been allowed, the completed 80-ft. section of pipe was lowered and then held in the proper position by the clamp, as was the first 40-ft. length. The next length of pipe, which was flanged at one end, was placed in a vertical position and the second vertical weld was made. After this weld was completed it was allowed to cool for about ten minutes and the completed section of pipe, which was approximately 100 ft. long and equipped with flanges at each end, was lowered a short distance in the shaft to give working clearance for the section to follow and then properly supported by chains to shaft sets. This method was used to keep the welding crew busy, as only two gangs of men were available, one being used to work on the surface assisting the welding crew during one shift, the second gang consisting of shaft men who lowered and placed the completed sections of pipe in position in the shaft. Two completed (approximately 100-ft.) sections were considered a shift's work. The shifts were alternated every six to ten hours, depending on how the work proceeded in the shaft.

The water column had been designed with the idea of installing it on week ends. When the time came to do the work, however, it was found possible to stop regular production in the shaft for one week, so that the work of installing the pipe proceeded continuously.

Difficulty was expected in making the vertical welds. The first to be made on the $\frac{3}{4}$-in. hydraulic pipe required slightly more than three hours, and the work was exceedingly tiring to the welder, as the No. 15 torch used with the heavy pipe generated so much heat that it was difficult for the operator to protect his face. Various other methods of making these welds were tried, such as using two operators and two torches. Although this resulted in saving time, it was unsafe, owing to the limited space and the danger of burning an operator's face. It was found difficult also to control the alignment of the pipe because of the unequal contraction. The best results were finally obtained by having two welders to a torch, each running it for twenty minutes at a time and alternating with each other.

In making the vertical welds on the extra-heavy pipe, it was necessary to modify the procedure. This welding was much easier than that done on the hydraulic pipe. Practically no difficulty was experienced with the vertical welds in the standard pipe, as these were made rapidly by one operator. The only real difficulty experienced with the vertical welding was in keeping the pipe in alignment, as it was found that after the weld had cooled the pipe would be out of line. This problem was practically solved in making the last few welds in each class of pipe. It was found that even two welders would work so differently from each other that the same allowance for draw in the pipe would have to be different for each man. A few welded joints were far enough out of line to need straightening. This was done in the shaft after one flange had been coupled up. Two torches were used to heat the welded joints, and the pipe was straightened over into line by means of jacks.



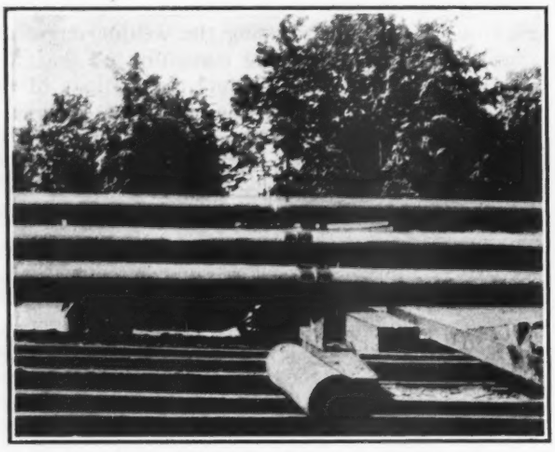
Starting the weld in 10-in. hydraulic pipe. Note "tacks" and wedges to allow for draw from heated weld

In making the vertical welds on the 10-in. hydraulic

pipe with ¾-in. wall, the average time was two hours and ten minutes per joint. The consumption of high-test welding rod for the eight joints was 83 lb. Oxygen consumption was 2,750 cu.ft. and the acetylene 2,750 cu.ft.

Welding the eighteen joints in the extra-heavy 10-in. pipe required 45 lb. of welding rod, 1,859 cu.ft. of oxygen, and 2,406 cu.ft. of acetylene. The time on the extra-heavy pipe averaged one hour per joint.

The ten joints in the 41-lb. standard pipe required 28 lb. of welding rod, 557 cu.ft. of oxygen, and 593



10-in. pipe that has been welded horizontally. Note the straightness of the pipe

cu.ft. of acetylene. Although the consumption of gas was higher than usual, it undoubtedly could have been reduced on the extra-heavy and standard pipe by using smaller torches and working more slowly.

The horizontal welds presented no special difficulties. No detailed records were kept of the gas and materials for these joints. The amount of acetylene gas recorded as consumed is in excess of the actual quantity, for the reason that consumption was so rapid that the tank could not give up the gas fast enough to be drained completely.

The entire job of welding the joints in the 2,000-ft. water column required 43 tanks of WK-type acetylene and 52 tanks of oxygen. This gives approximately 10,320 cu.ft. of acetylene and 11,440 cu.ft. of oxygen. The total cost of the gas and 225 lb. of manganese high-carbon welding rod was $590.32.

In lowering the 100-ft. sections of pipe in the shaft compartment the lower flange was equipped with a pointed birdcage-like device to prevent the flanges from catching on the shaft sets. No difficulty was experienced in handling these heavy sections, as the pipe did not swing nearly as much as sections only 20 or 40 ft. long.

Great care was taken in designing the pipe clamps. The clamp for the hoist tackle and the clamps at the collar of the shaft were used to hold the assembled sections in place for welding. These were designed and built in the company shops and were carefully tested in a hydraulic press before being used.

As far as the construction method used was concerned, it would have been possible to eliminate all the flanges by lowering the pipe in 100-ft. sections and making the necessary connecting welds in the shaft. Had the welding operator been used to working in a shaft, no great difficulty would have been experienced in this part of the work. It was not possible to plan for a definite shutdown sufficiently in advance, however, to allow for the manufacture of the pipe.

In checking up the work of the welders it was desired to make certain that the vertical welds would be as strong as the pipe itself. The men were given an opportunity to make a few vertical welds while doing the horizontal work. From one of these welds samples approximately 1¼ in. wide and of suitable length were cut. These were tested in the laboratory. Results of tests made at the Michigan College of Mining and Technology on two representative samples are given. One of these samples was taken from the middle of the weld after proper working temperatures were reached. The other piece was taken from the beginning of the weld. The latter broke close to the union of the welding material and the pipe. Breaking stress was 46,300 lb. per square inch. The sample broke practically without any elongation. The piece from the center of the weld broke outside the weld in the pipe material. Records show that the ultimate strength was 53,300 lb. per square inch and the final breaking point was 36,700 lb. per square inch. This proved that the method of welding was correct. Precautions were taken so that the welder in completing the weld melted out at least 2 in. of the weld which was first made.

It had, of course, been estimated that welding would be somewhat cheaper than using flanges, besides having other advantages. The comparison of the cost of the completed work with that estimated for a completely flanged job should be of interest. It is given in the accompanying table.

Comparative Cost Data—Welded Joints Versus Flanged Joints

	Welding Job	Flanged Job
Pipe clamps and supports and special tools	$173.42	$173.42
Labor installing all pipe work in shaft and pump room	1,791.00	1,870.00
Labor and material installing column footing	879.00	879.00
All pipes and fittings for water column and pump room as installed	17,800.00	17,800.00
18 Series 900 SWP Std. 10-in. forged steel flanges, bolts and gaskets; also labor of attaching and back-welding	.....	3,130.00
36 Series 600 SWP 10-in. flanges attached to pipe	.....	4,600.00
24 Extra heavy 10-in. forged steel flanges attached to pipe	.....	240.00
Welding—labor and material—chargeable directly to welding	1,092.00	.....
Total	$21,735.42	$28,692.42

The items of supervision are not included, as this would be the same in either case. It is possible, moreover, that the labor of installing the flanged pipe would be higher than estimated, since it was thought that at least one additional shift would be required for this work. It is therefore evident that the welded pipe not only gives more room in the pipe compartment, but it also weighs considerably less and costs less.

If a pipe is damaged from any external cause, additional pieces can easily be welded into place in the shaft. This will be much simpler than trying to handle flanged sections in such close working places.

The pipe column was put into service discharging 750 g.p.m. without any preliminary testing and no leaks of any kind developed.

New European Electrolytic Zinc Plant?

The Chemical and Metallurgical Corporation now has in England two American experts for consultation regarding the erection of an electrolytic zinc plant, according to a report issued by this company. England and Norway are being considered, cheap power being essential. Zinc residues from a new ore treatment plant being built at Runcorn, England, will thus be treated.

Natural Solidified Petroleum— Its Mining, Treatment, and Uses

By W. F. HARTZELL
Barber Asphalt Company, Philadelphia

THE principal sources of native lake asphalts are at Brighton, Trinidad, B.W.I., and the Bermudez Lake, in Venezuela. These deposits are described as lakes because they consist of great expanses of a more or less mobile material covering many acres, and resembling in many ways expanses of water. The Trinidad lake has an area of about 100 acres and is perhaps 200 ft. deep at its deepest point; the Bermudez Lake has an area of more than 900 acres, but its depth is only 7 to 9 feet.

Mining native lake asphalt is a simple operation. The crude asphalt is dug from the surface of the Trinidad and Bermudez lakes by laborers, with picks. The chunks of asphalt are thrown into skips carried on small platform cars and eventually dumped into the hold of a ship. While the crude material is being transported to the United States it runs together into a compact mass, and upon the arrival of the ship in this country the asphalt must again be picked from the hold of the ship by laborers.

It is not difficult to refine native lake asphalt. A supply of the crude material is placed in a large rectangular tank holding about 70 tons, which is equipped with coils of pipe carrying steam at a pressure of 125 lb. and at about 325 deg. F. The heat melts the asphalt and removes the water; agitation is provided by passing some of the live steam through the crude material while it is heating. When evolution of steam stops and the melted mass has become quiet, it is drawn from the bottom of the tank into open barrels and then placed on flat cars for transportation to different parts of the country. This refined asphalt is fluxed to the desired consistency, and used for paving streets and roads; in the manufacture of asphalt shingles and roofings; in the construction of asphalt built-up roofing, and asphalt mastic floors; and for waterproofing large engineering projects such as subways, tunnels, bridge structures, dams, and reservoirs.

Another form of asphalt is known as gilsonite, found in immense deposits in the western United States, most of which are in Utah. Gilsonite is deposited in long, narrow, vertical fissures or veins, running almost parallel to one another in a straight northwest-southeast direction. They range from a few miles to 30 or 40 miles in length. In width they vary from 1 ft. in some veins to 20 ft. in others, though a fair average is 4 ft. Rock bottom has frequently been struck close to the surface; but at other points rock has not been struck at a depth of 700 ft.

Natives digging asphalt in Trinidad asphalt lake, British West Indies
The small car is used to carry the lumps of asphalt to the refinery

Supporting these veins of gilsonite are walls of limestone and sandstone, which extend for the most part sheer, smooth, and almost exactly parallel to one another. The two walls on each side of the gilsonite vein match almost exactly, which indicates that perhaps at some time the two masses of rock were one. Frequently, faults occur in a vein; for example, a vein may at a certain point be displaced laterally to one side or the other, either throughout its depth or only part way down, without changing its width or general direction; or only one wall may be so displaced, thus widening or narrowing the vein. Then again the vein may be completely blocked at some point by a rock wall which necessitates tunneling beneath to obtain the gilsonite. Occasionally, boulders of sandstone or limestone may be found imbedded in the asphaltum, probably coming from the retaining walls when the gilsonite was still a liquid mass. Where this occurs in a vein, further mining must be abandoned, as

it is almost impossible to separate the gilsonite from the imbedded rock.

All of these conditions make necessary a highly specialized type of mining engineering. The initial operations are simple enough. First, the overburden of dirt and vegetation is removed at a given point and the dirty, weathered ore at the top is thrown away. As soon as clear, sound ore is reached, the miners start digging into the solid mass with pickaxes, working downward along a rather steep slope—about 60 deg. incline—from one or both ends of the claim. After reaching a predetermined depth or a substratum of rock, they go back to the top of the slope and strip an additional layer of ore from it, several feet thick, working their way down just as before. Stripping ore by this process, from the slope in successive layers, continues until the mine is exhausted at that point.

When the excavation has progressed far enough, a wooden platform or deck is built about 20 ft. below the surface, traversing the entire length of the worked claim. This platform serves to catch any rocks that may become detached from the exposed walls above, and also serves as a runway for the small trucks that convey the sacked ore to the entrance of the mine. Miners reach the bottom of the mine by a series of ladders mounted vertically, one above the other, with small inclosed wooden landings between them and extending to the bottom of the shaft, which may be as much as 700 ft. deep.

At 300 ft. the shaft is almost completely dark; the plankway near the top shuts out most of the light. In such a place the miners work by the light of small electric lights in their caps. Some are picking gilsonite while others are engaged in shoveling it into burlap bags, which are then raised by a hoisting engine, three at a time, by

Entrance to the Colorow lode in the Rainbow gilsonite mine

Gilsonite ore is not difficult to break. It exists in a solid black mass, somewhat of the consistence of a block of ice. Frequently, all that is necessary is for the miners to pick away at the ore in immediate contact with the smooth rock walls on either side of the vein. Once the bond with the rock is broken, the brittleness of the ore is such that, aided by the pressure stresses of the rock wall, the entire mass of gilsonite may break, splinter, and tear apart—sometimes suddenly, and with the report of an explosion—and fall in a shower of large and small boulders and finely crushed particles, down the steep incline.

As the ore is removed, the rock walls are braced by wedging logs about 8 in. in diameter and cut to the proper length. The wedging logs are placed horizontally between the walls and are spaced about 6 ft. apart. This system of bracing is repeated at every 6 to 10 ft. of depth down the entire shaft.

means of a steel cable. After being raised to the surface, gilsonite is carefully graded, and the sacks are sewed with strings of different colors to differentiate the "selects" from the standard grade, which is known as "gilsonite." In due course the bags of material are placed on flat cars and transported over the narrow-gage railroad operated by the Uintah Railway—65 miles long—that traverses the Book Cliff range of mountains, 8,500 ft. above sea level. This descends at the steep grade of 7½ per cent over one of the most tortuous mountain railroad tracks in the world, frequently turning and twisting like a snake at the very brink of sheer precipices, and finally reaches the central depot at Mack, Colo., where the warehouse of the Gilson Asphaltum Company is maintained.

Gilsonite is used in the manufacture of black varnishes, baking enamels, japans, printing inks, insulating compounds, roofing and waterproofing compounds, and molded goods.

DISCUSSION

The Way That Labor Is Going

THE EDITOR:

Sir—The address given by Charles M. Schwab, chairman of the board of directors of the Bethlehem Steel Corporation, before the American Society of Mechanical Engineers last month, in which he defended the payment of high wages to labor, was one of the most notable utterances in the annals of labor.

Mr. Schwab stated that many things had been learned about the labor question over the period of nine years since the co-operative plan first made an effort to adjust the grievances of the employees. It was followed by a representation plan, "a phase of constructive co-operation with the management," said Mr. Schwab, adding, "On the one hand, the employees have gained a more intimate knowledge of their company and its objectives, and, on the other hand, the supervisors have come to realize more definitely than before their function as leaders rather than drivers of men."

As we look through the pages of history, labor has been "driven"—first as slaves, and then very frequently as paid employees. Finally the proverbial worm turned and demanded shorter hours and more compensation. At first the employer could not realize why less work and more pay would result to his advantage, for at that time the words "co-operation" and "service" were not understood from a standpoint of output. Now these words have taken on a new meaning. Mr. Schwab says that a series of conferences are annually held between the Bethlehem company and its employees at which an annual report is made by the corporation to the employees just as it is made to its stockholders. As a result of this mutual understanding the employees of the Bethlehem Steel Corporation own 17 per cent of the company's stock, valued at $17,000,000.

During the last few years large numbers of delegations and students of economics have come from abroad to study the industrial systems of the United States. Some have submitted long reports attempting to reveal the secret of our unprecedented prosperity. Of these, many have missed their objective, as their reports failed to emphasize the encompassing spirit of co-operation which exists between labor and capital in many large industrial organizations of the United States. And the element of service, which is the natural sequence of such a complete understanding, has apparently not been heralded abroad with much vigor. The word "service" has been overworked in this country for several years, but since service is so vitally a function of labor, one may be pardoned for bringing it to the fore again. Mr. Schwab explains that "the practical science of humanizing industry" calls for "expert service" in the field in obtaining the confidence and good will of the employees. This he considers just as important a study as the engineering thought given to the strength and utilization of materials in the plant. And he adds:

"Out of its solution comes a new code of economics, a code that aims not only to provide food and clothing and shelter, but also to elevate society at large and to place a true dignity upon labor, a dignity that yields a fuller and happier measure of life."

"Fair wages for efficient services" are what labor requires, in Mr. Schwab's opinion. As a natural consequence labor will then be endowed with "a dignity that yields a fuller and happier measure of life."

New York City. V. V. CLARK.

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Electrolytic Zinc Plant Practice

THE EDITOR:

Sir—I note that Mr. Arthur A. Zentner, in his review of "Electrolytic Zinc Plant Practice" in your issue of Dec. 10, states on page 926, "Trail, with its high zinc, 50 per cent, but also high iron, uses a lower temperature and floats the residue from the agitation tanks to recover unroasted zinc sulphide, which is returned to the roasters." I wonder if he is correctly informed as to present practice at Trail. His statement is correct for 1923 and for some time after; but when I visited the plant in April, 1926, this particular practice had been abandoned. The material from the acid pachucas had gone to classifiers, which sent a sand to a ball mill and then to a flotation machine for the recovery of zinc sulphide. Classifier overflow was thickened and also floated. The overflow from the thickener and tailing from the flotation machine were sent to another thickener making solution for the neutral circuit and residue for filtration and disposal to the lead plant. The concentrate after thickening and filtering went back to the roasters. At the time of my visit, sand from the ball mill was returned to the acid pachucas without further treatment, eliminating flotation, thickening, filtering, and re-roasting. It would be interesting if those familiar with present practice at the plant would analyze for your readers the comparative advantages and disadvantages of the two methods of handling the acid pachuca residues.

Pullman, Wash. L. O. HOWARD.

THE EDITOR:

Sir—Mr. Howard is correct in his statement that Trail has abandoned flotation of unroasted zinc sulphide. Since writing the article I have had the privilege of going through the electrolytic zinc plants in Canada and the United States, but for obvious reasons did not feel free to make any changes in it. In fact, it was turned in to your San Francisco office before starting for New York. I am pleased to have Mr. Howard call attention to the point so that it can be corrected.

No doubt one reason for abandoning the practice is the increased ratio of zinc to iron in the present concentrates. This permits more complete roasting without forming a prohibitive amount of insoluble zinc. Another is that taking out a large part of the lead and iron in the concentrator removes with them a portion of the harmful elements, so that less iron in solution is needed for purification. More complete roasting leaves less soluble iron in a calcine. Another is that higher acid tends to dissolve more iron from any given calcine.

The simplifying of practice is permitted by the changed composition of the concentrates and the higher strength acid used.

A. A. ZENTNER.

London, England.

* * * *

Defining Engineering

THE EDITOR:

Sir—In talking with my friend W. W. Edwards, an engineer and geologist, recently about the discussion on a definition of engineering, I quoted to him T. A. Rickard's ideas on the subject, as expressed in a recent article of his in *Engineering and Mining Jornal,* and asked him if he could improve it. In reply, he suggested: "Engineering is the scientific application of natural laws to the use of mankind," or to man's wants or needs.

Certainly either T. A.'s definition or this one is far better than the one suggested by the committee.

El Paso, Tex. G. L. SHELDON.

By the Way

Mere Words

ONCE upon a time "beneficiation" seemed a word unnecessarily long—it had at least one syllable too many, and, furthermore, was always getting mixed up with "benefaction." Another word, however, has come into vogue to afflict us, and that is "geophysicist." Not that we haven't it under complete control; no, indeed, we can almost make it do gymnastics; but it sounds "high hat" and withal is quite a jaw-breaker. For "geology" we have plain "geologists," and for "geography" there are "geographers"; so it seems unfortunate that we cannot do better than "geophysicist" when we consider geophysics. It might help to popularize the science if a simpler term for the geophysical scientist were found. As a matter of fact, some geophysicists prefer the term "physical" to "geophysical." The former term, however, is ambiguous. "Physical exploration," for instance, suggests manual labor with pick and shovel, and not at all the exquisite manipulation of torsion balances, magnetometers, and seismographs in which the geophysicist delights. Suppose "geophysicist" be analyzed or scrutinized, syllable by syllable. "Ge," to begin with, suggests the near-oath that some anemic individuals use when they wish to swear, possibly in a parson's presence; "o" has a Celtic suggestion that seems out of place in a scientific word, where Latin or Greek would be more appropriate; as for "phys," pronounced "phiz" or "fizz"—there's the rub; it makes faces at you and has altogether a ridiculous sound. In "geologist" one slurs the "geol," so that it sounds quite jolly, but in "geophysicists" you dwell on each separate part and, in a way, rub it in. Here, indeed, is a chance for simplification and greater euphony. Suggestions will be welcome.

Zinc Bands Protect Coconuts From Tree-Climbing Rats in Society Islands

ZINC BANDS are to be placed around the trunks of coconut trees in the Society Islands to prevent rats from climbing the trees and eating the green fruit, according to a recent report of the U. S. Department of Commerce. Coconut plantation owners in the colony have found that if bands of zinc, 14 in. in minimum width, are placed around the trunks of the mature coconut trees, 30 to 35 ft. from the ground, the fruit is effectively protected from marauding rats, as they cannot climb over the zinc bands. The cost of such protection is about 45c. a tree, including the cost of the band and the labor of attaching it.

* * * *

Lament of the Veteran Battery Man

BY W. A. STEDMAN
Westport, Connecticut

As I look acrost the canyon from my little cabin door,
I ketch myself a list'nin' for the rumble and the roar
Of the mill down by the Two Spot whar they use' ter use the stamps,
But now new fangled gadgets make it like all modern camps.

And way up here whar I live 'mongst the spruces and the pines
No sound comes driftin' up the gulch to tell me if the mines
Are runnin' same as usual or mebbe been shut down—
You hear no noises from the mill 'til almost into town.

When Bobby Miles and Tommy Glynn and me and Happy Bill
First opened up the Two Spot mine and built our little mill,
We shore did like to listen to the steady pound and roar
Of twenty stamps a droppin' fast on good free millin' ore.

And watch the pulp a ripplin' 'crost each clean and shinin' plate
And sort o' guess at how much gold we'd have next clean-up date.
We all was young and careless then. I reckon like all boys
We rather liked the thing the best that made the biggest noise.

The ore was close to grassroots and was mighty easy got,
And what went with the tailin's didn't worry us a lot.
But bye and bye the ore turned base and then there came a day
When, spite of all that we could do, we couldn't make her pay.

With most of us old-timers it was easy come and go,
And we was all flat busted when the millin' ore run low.
So when that minin' engineer come 'round, we had to grin
And take the price he offered, 'though to us it seemed a sin.

Then when that eastern comp'ny come and took the mine and mill,
And we each drew our little share and headed down the hill,
They said, "Stamps ain't efficient and we're going to make a change"—
Then trundled in a tube mill which to us looked mighty strange.

Now, when I see that tube mill with its squishy sort of rattle,
It shore does seem lots easier than when we use' ter battle
With busted cams and tappets which we never could keep tight,
And all those things which never seemed to happen 'cept at night.

I'm gettin' old and mebbe sort o' stubborn in my ways—
It's hard to see whar things are better than in older days.
I'm feelin' kinder homesick, and I guess I always will,
For that sort o' husky music from the little old stamp mill.

Consultation

Banthein Leaching Process

"What is the Banthein leaching process, and is it true that it has been used successfully for the treatment of copper ore?"

Some confusion has evidently arisen, because the Banthein process has been tried in the vicinity of the Chilean copper mines, but so far as is known it has no application to copper ores, or in fact to any typical ore, metallic or otherwise, that contains material of widely different physical characteristics and specific gravities. The process is based on the assumption that an ore, if ground sufficiently fine, could be treated by upward percolation and the particles of insoluble kept in their respective positions of stationary suspension.

Many attempts to apply the principle, if such it can be called, were made in the early days of the cyanide process, when intensive efforts were concentrated on the problem of treating the slime portion of oxidized ore; but results were generally unsatisfactory, and no technical development of any moment resulted.

In Germany it is understood that a measure of success in treating a potash mineral has been obtained by the adoption of what is known as the Banthein process; but the raw material is in no way similar to a metallic ore or to any other raw material containing appreciable quantities of insoluble of varying specific gravity. In such a field it can have no possible commercial application. The reasons are not hard to find:

1. The excessively fine grinding of a raw material that does not need such reduction in order to expose the soluble to the action of a solvent would be clearly an avoidable expense and a complication.

2. If an attempt be made to percolate in an upward direction through a pulp of fine material in suspension, such material containing the customary constituents of an ore—as silica and colloidal clay, for example—the vessel in which the operation is performed must inevitably act as a classifier. If, by adjustment of flow rate, the particles of lower specific gravity are retained in stationary suspension, the particles of higher specific gravity will tend to settle. Or, conversely, if the particles of higher specific gravity, during the same method of control, are retained in stationary suspension, the particles of lower specific gravity will escape with the overflowing effluent.

3. It is obvious that the entering lixiviating solution must be applied evenly over the lower part of the charge, and that, with a fine material, the use of an ordinary bottom support is impracticable. In an attempt to obviate the difficulties experienced in the application of the Banthein process to an ore of normal gangue characteristics, a perforated false bottom is used, beneath which the lixiviating solution is introduced. This permits even distribution but invites complication when upward lixiviation is concluded and when it is necessary to drain the charge prior to discarding the residue. It will be seen that adequate drainage is impossible under such conditions; and that, unless excess wash is used, the consumption of water will be excessive

In the attempted application of the Banthein process to the treatment of ore, its sponsors have maintained that the escape of slime with the effluent is unimportant, and that the contaminated leach liquor can be reintroduced under the charge, or the slime removed in settlers. This is merely an evasion of the fact that any method of recovering a soluble associated with an insoluble ceases to be a leaching process with economic or technical possibilities when part of the insoluble is removed with the lixiviant.

World's Deepest Mine in 1927

"What is the deepest mine in the world?"

"Constant readers" of the *E. & M. J.* will perhaps remember having seen this interesting question asked and answered before. However, among other good reasons for answering it again is the fact that greater and greater depths are being reached in many mines, and the championship may change hands some of these days. According to the latest available information, the leading mines line up as shown below. Possibly sinking, done since the data on which the ranking is made were issued, has altered the situation. We will be glad to publish corrections or supplementary data from readers.

Village Deep—The Turf or No. 3 shaft of the Village Deep mine, on the Rand, in South Africa, is bottomed 7,264 ft. from the collar. However, the collar itself is 366 ft. below "datum," or the mean level of the Reef. It might be argued that the workings therefore are 7,630 ft. deep. In either case the shaft holds first place.

St. John del Rey—Horizon 24 of the Morro Velho mine, in Brazil, is 6,926 ft. below the elevation of the collar of the first of the six vertical shafts through which the lowest workings are reached. Five of these shafts, obviously, are internal, being connected by horizontal workings.

City Deep—Third place (perhaps second if the latest data were available) goes to another Rand gold mine—City Deep. Its No. 4 sub-Vertical shaft reaches 6,900 ft., according to the most recent annual report. Presumably this is calculated from the collar of the shaft.

Ooregum, Mysore Gold, Robinson Deep, Crown Mines—Data are not at hand to place these four; the first two are in the Mysore gold district in India, and the others are on the Rand. Each has workings close to 6,000 ft. deep. The last annual report of the Ooregum company states: "A new circular shaft has been sunk to a depth of 4,600 ft. (52d level); and an auxiliary shaft has been sunk to the 68th level." If the distance between levels remains the same as the workings become deeper the 68th should be approximately 6,000 ft. deep.

Calumet & Hecla—In the United States, Michigan boasts the deepest "hole," Tamarack No. 5 shaft being 5,309 ft. below the collar. No. 2 shaft of the Quincy Mining Company is nearly as deep vertically, though it has an inclined opening.

Kennedy—The greatest vertical depth reached in the gold mines of California is 4,460 ft. in the Kennedy mine. The adjoining Argonaut mine is bottomed, according to the latest data, at 4,300 ft.

Bendigo—The Victoria mine, in the Bendigo district of Australia, is 4,300 ft. deep.

Incidentally, it is significant that, with the exception of the Michigan copper mines, all of the deep shafts are sunk in the exploitation of gold. Irrespective of the geographical situation, whether in Africa, South America, Australia, Asia, or North America, the habit of gold deposits is to continue in workable concentrations far into the crust of the earth.

INDUSTRIAL PROGRESS

An 800-hp. hoist equipped with spherical anti-friction bearings, Bunker Hill & Sullivan mine, Idaho

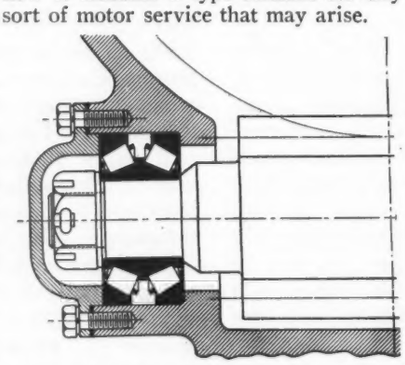
Anti-friction Bearings—Their Widening Use in the Mining Industry

ANNOUNCEMENT has recently been made by the largest manufacturer of anti-friction bearings that $4,000,000 is to be spent in 1928 in increasing the company's production facilities. This fact may be regarded as an index of the widening application of anti-friction bearings to industrial equipment.

The company mentioned above reports that the year 1927 was marked by a steadily increasing use of its bearings in the various types of equipment built for mining and metallurgical practice. New applications were made, and, in addition, a marked increase in the use of such bearings in applications already developed was recorded. Among the latter the most striking example is that of mine cars. The standardized loose wheel mounting, originally developed for cars used in coal mining, has proved so successful in metal mines that several operators have placed large orders for cars thus equipped, among them two of the largest mining companies in the United States. The Timken bearing is referred to.

Another phase of interest in this field is the growing use of the bearings in electric mine locomotives. In this application the use of the bearings has been extended to include the armature shafts of the driving motors as well as the journals of the locomotive proper. Considerations governing the former application were: the ability of the bearings to withstand the thrust and shock loads transmitted from the driving mechanism of the locomotive; their resistance to the vibration and racking caused by travel over rough and uneven tracks; and their ability to operate over long periods without frequent or copious renewals of lubricant. The application of the bearings to the locomotive journals came about as the logical result of their success in meeting requirements of great similarity in mine car wheels.

Application of the bearings to electric motors has also increased, both with respect to the number of motors equipped and as to the various conditions of type, speed, and service represented. The line of bearings available for this service has been extended by the addition of a new type of bearing—namely, a self-contained double row bearing—so that now it includes a type suitable for any sort of motor service that may arise.



One bearing (tapered roller) of layout for worm shaft of worm reduction gear which takes care of movement due to shaft expansion

Another class of equipment that shows a considerable increase in the number of new applications is that of gear reduction units. One of the factors that has aided progress in this department of industry is the solution of problems in connection with certain types of gear-reduction units that have hitherto rendered the application of bearings impracticable.

In both helical and double herringbone gears there is a tendency toward applying the bearings to units of constantly increasing horsepower capacity. In the case of the former, a typical example is that formed by a 350-hp. single helical unit built by the R. D. Nuttall Company, of Pittsburgh, and recently placed in service. In this case the pinion shaft is supported by four bearings, two being mounted back to back at each end. Those at one end are mounted so as to hold the pinion in rigid alignment with respect to the main gear, whereas those at the other end are mounted in such a way that the shaft is permitted to float through them. This arrangement is provided partly to allow for shaft expansion and partly to allow the pinion to locate itself with respect to the gear. The mounting of the gear consists of a single bearing on each end of the shaft, arranged to preserve rigid alignment.

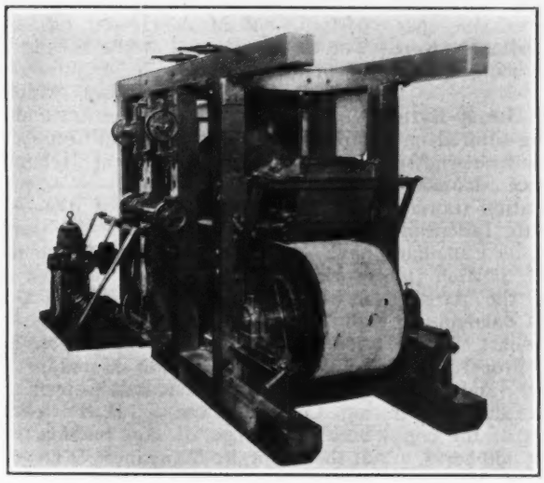
In the case of double herringbone gears, as built by the Farrel Birmingham Company, the mounting of a 1,500-hp. gear of this sort should serve to show the general method adopted. Both the pinion and gear shafts are mounted in double row bearings—that is, bearings which consist of a single inner race, tapered to an apex in the center, two sets of rollers and cages, and two outer races. The pinion shaft mounting comprises two of these bearings, one at each end, the inner races being pressed on the shaft and the outer races being pressed into the housing. The housing in reality forms a retainer for the whole bearing, and is movable with respect to the bearing pedestal. Once the pinion is definitely located with respect to the gear, the two retainers are given a fixed position by means of shims.

The arrangement on the gear shaft is the same, as far as the bearings and retainers are concerned. Provision has been made for the longitudinal movement of one bearing, retainer and all, both to take care of shaft expansion and to allow for some movement of the gear in maintaining proper tooth relation with the pinion. The other bearing is rigidly mounted to preserve the proper alignment of the gear shaft.

A form of mounting has also been de-

veloped for use with worm gears which is intended to solve the problem of allowing for shaft expansion due to heat, and at the same time maintain the proper alignment of the worm and wheel. The mounting on one end of the worm shaft consists of a double-row bearing, arranged to hold the shaft in rigid alignment. On the drive end the outer races are mounted in a retainer, and the inner races are located on the shaft by rings on each side. As a consequence, the whole assembly at this end can move in case of shaft expansion, while the desired alignment is maintained by the rigidity with which the shaft is held at the other end.

Several new developments took place with respect to material handling equipment, especially in belt conveyors. Three manufacturers have introduced new and improved forms of belt idlers, return idlers, and other variations of belt-conveyor equipment in which tapered roller bearings are employed. The essentials of the bearing mountings are practically similar in all forms, the principal ideas being to provide storage space for a supply of lubricant sufficient to last over long periods without renewal, and to protect the bearings from damage caused by water, dirt, grit, or any other foreign substance entering from the outside. For this reason the bearings are mounted in tubes, the interiors of which provide a reservoir for grease, and are protected by closures designed to prevent leakage and to seal the bearing away from any outside contamination.



A 60,000-amp. turn magnetic separator with tapered roller bearings on pulley shafts

As far as metallurgical machinery is concerned, the most striking development is, of course, that of bearings for the roll necks of various kinds of rolling mills. The bearing developed for this purpose consists essentially of two double cones, or lower races, four sets of rollers, with individual cages, and three cups, or outer races, one of which is double. It is made in capacities up to and including 2,000,000 lb. at 100 r.p.m. radial load, and for several neck diameters. Bearing applications have also been made during the year to other types of heavy-duty mill equipment, such as pinion stands, ingot cars, slag cars, and charging box cars.

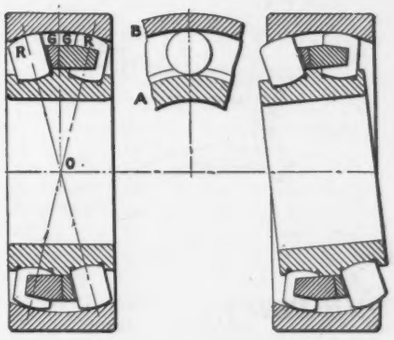
Another new application in this field was made recently by the Dings Magnetic Separator Company to a 110-volt, 60,000-amp. turn magnetic separator for use in treating zinc ores. In this case the drive and idler pulleys of the main belt are both mounted on tapered roller bearings, as are the pulleys of the cross belts by which the separated iron is carried away from the machine. In all, ten bearings are used in this machine.

Application of the Spherical Bearing

A type of bearing different from the foregoing is the SKF spherical bearing, a cross-sectional view of which is shown at the right. This bearing is made of high-carbon chrome steel hardened throughout. In principle, it differs from the conventional type of roller bearing in that it is self-contained and non-adjustable. In its frictional characteristics it approaches a ball bearing. With it starting friction is about the same as running friction.

Some interesting applications of these spherical bearings have been made to mining and metallurgical equipment. In one large mine, they are said to have increased the life of locomotive motors over 50 per cent before overhauling was necessary, and twenty-three locomotives ranging from 6 to 15 tons are equipped with them. The ring-type sleeve bearing formerly used in this mine gave trouble because of oil leakage onto the commutator bars and into the windings. The new bearings, with their dust and oil-proof housing, have eliminated this trouble. An experienced lubricating man greases all bearings of the locomotive once a month.

At another mine spherical bearings are used with a 400-hp. motor direct-connected to a pump, which is also mounted on spherical roller bearings. Uninterrupted heavy duty is required. Motorized pump equipment with such anti-friction bearings offers an opportunity for reducing the maintenance cost where tailings are being pumped. Spherical bearings of this type are being used on sheave wheels by the United Verde Copper Company. At its plant an 8-ft. idler sheave is equipped as stated, the bearings carrying a load of 11,000 lb. at 37 r.p.m. The head sheave, 12 ft. in diameter, is also carried on bearings of the type mentioned, these taking 39,000 lb. per bearing.



Cross-section of spherical bearing. "A", the inner race, rigidly secured to shaft, "B", outer race, in contact with housing. Elements "R" roll between their line contact on the outer race. "G", bronze retainers for keeping elements properly spaced. Inner surface of outer race is spherical, generated from the center, "O"

In the hoisting field an outstanding application of the spherical bearing is its use on the center and on one of the end bearings of an 800-hp. double-drum electric hoist at the mine of the Bunker Hill & Sullivan company in northern Idaho. This installation is shown in the illustration on page 258.

Marked advance in the application of these spherical bearings to large mine fans is also reported. In one instance they have been applied to a 12-ft. fan having a 4⅞ in. shaft. In this case the use of these bearings has eliminated the need of belt replacement twice a year, which formerly was necessary because of the high starting torque and bad slippage when plain bearings were used.

As for crushing equipment, the most important advance made during 1927 was in coal-pulverizing machinery. In mills, in many installations, large gear drives have been equipped with spherical bearings.

In summing up it may be said that in the metal-mining field a definite trend toward the use of large anti-friction bearings is visible. It is well known that neglect in lubricating a plain bearing causes almost immediate failure, whereas a well-designed anti-friction bearing will run for six months with initial lubrication, and under favorable conditions, even for a year without further attention. This is undoubtedly an advantage when the inaccessibility of lubricating bearings on certain equipment is considered.

BULLETINS

Lifting Magnet — Electrical Controller and Manufacturing Company, Cleveland, Ohio, in a new folder describes its improved No. 6, Type SA lifting magnet for lifting hot ingots and for other applications.

NEWS OF THE WEEK

Summary

WASHINGTON reports discovery of quicksilver in Haiti and of potash deposits in Central America.

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Eastern capital becomes identified in plans for exploitation of California tin prospects.

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London takes interest in Rhodesian base-metal companies, their position and prospects.

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Bolivia considers aiding development of tin district by the use of aërial surveys and taxation modifications.

* * *

Interest in new Hudson Bay M. & S. Company shares features the Toronto stock market.

* * *

Mohawk mine, in the Michigan copper district, establishes a low cost record for the property during 1927, besides breaking its former production record.

* * *

Phelps Dodge Corporation lets contract for driving of 4,300-ft. tunnel to provide gravity drainage of mines in the Morenci district of Arizona.

* * *

Ludlum Engineering Corporation begins active operations on dredge ground along Foots Creek, near Gold Hill, Ore.

* * *

Discovery of new vein on Idaho Maryland and numerous transactions in mining property attract attention in California.

* * *

Premier Gold acquires Silverado properties in British Columbia.

* * *

North Lily plans an expansion of its present surface plant near Eureka, Utah.

* * *

Childress Lead & Zinc Company shows faith in Tri-State by acquisition of two new properties there.

Two Montana Consolidations Are Completed

Lone Pine and Argyle Silver Mines Capitalized at $500,000 by Butte Interests—Important Decision in Apex Litigation

UNDER the name of the Quartz Hill Mining Company, a group of Butte men have consolidated the Lone Pine and Argyle Silver properties in the Big Hole River district, six miles from Deweys Flat, Beaverhead County. The consolidated company will have capital of 1,000,000 shares, 50c. par. Both of the properties formerly were producers, the Lone Pine being opened by a 1,000 ft. shaft.

Stockholders of the Lindy-Butte Mines Company are being offered one share of stock of the Butte Independent Mines Company for three shares of Lindy-Butte in a consolidation transaction just completed. Butte Independent is sinking a shaft on its Canadian claim in the southwest portion of Butte, 1,500 ft. west of the Ardsley Butte workings, and has encountered commercial ore in the shaft, in the granite north of the vein proper. The ore contains lead, silver and zinc. Lindy-Butte has sunk a shaft to a depth of 75 ft. Holdings of the consolidation consist of about 480 acres.

In the apex litigation of Midwest-Butte Development Company against Butte West Side Mines Company concerning the so-called deeded, or northeast, portion of the Minnie Jane claim, which covers about 800 ft. in length of the vein, Judge Bourquin, in the Federal Court of Butte, has rendered the following decision: "West of the main fault, the apex is in plaintiff's premises for 76 ft., and the vein continues to the orebodies below. Between planes parallel with the end lines, projected 540 and 621 ft. west from the east end line, plaintiff is entitled to recover. In all else, decree is for defendants. No cost to either party."

According to advices received from Radersburg, Broadwater County, Mont., Butte Copper Consolidated Mines Company has completed its new 250-ft. shaft and sump on the Joe Dandy group, this shaft being standard two compartment and equipped with electrically driven machinery.

In drifting west on the 350 level, the ores of the Ardsley Butte Mines Corporation, in its Highland group, have materially increased in lead contents. As a result the company has made a contract with the W. A. Clark interests to handle its ores at the Timber Butte mill. Shipments are being made at the rate of about 100 tons a day.

The new 175-ton cyanide plant of the Montana-Idaho Copper Company started operations, under supervision of C. L. and M. A. Hewett, on Feb. 1. The mill is located at the Spring Hill property at Unionville, 4 miles south of Helena. The company, which is also operating three properties and two mills near Winston, Broad County, has opened a general office at Helena, in charge of Jesse Gibson.

Two representatives of the Allis-Chalmers Company, of Milwaukee, have been active in construction work in Butte during the last few months. G. H. Briggs, electrical engineer, has been aiding in the construction of the new 5,000-ft. electric hoist being installed at the Mountain Con property of the Anaconda Copper Mining Company, and J. P. Powell has been in charge of construction work at the Domestic Manganese & Development Company.

North Lily Plans to Enlarge Surface Plant

THE sum of $75,000 has been appropriated for completion of the North Lily surface plant near Eureka, Utah, adjoining the Tintic Standard mine. Actual construction is contingent upon the building of a spur by the railroad company to the end of the proposed aerial tramway costing $30,000. Ore bins, surface buildings, and other equipment will bring the total expenditure, with money already spent, up to $100,000. Work of installing the equipment and putting the shaft in readiness will take about ninety days, during which production will be curtailed in order to make the installation.

The three-compartment shaft has penetrated to the 700 level driven from the Tintic Standard Mining Company. Ore and waste previously handled through the Tintic Standard No. 2 shaft will find an outlet through the new North Lily shaft as soon as it is equipped.

Quicksilver Reported Discovered in Haiti —Germany's Tin Imports Increase —Potash in Central America

By Paul Wooton
Special Washington Correspondent

DISCOVERY of quicksilver deposits in Haiti have been reported unofficially to officials in the government interested in future supplies of strategic minerals. As this is written, no opportunity has been afforded to verify the report or to determine further facts as to the occurrence of the deposit. Strangely enough, a report was received at practically the same time telling of the discovery of potash salts in a Central American country. The name of the country was withheld, and officials are reserving comment until further facts can be obtained.

Preliminary figures reaching Washington indicate that Germany's imports of tin during 1927 increased 45 per cent. This is thought to account for the fact that the visible supply of tin has remained the same, despite the increased world production in 1927. The figures just received indicate that Germany practically has attained a rate of consumption equal to that of the pre-war period.

Dredging operations in the Malay peninsula are expected to continue at an increasing rate during 1928, owing to the fact that large additional capital has been induced to enter the business by the high price for tin which has prevailed. One result of this activity will be the reduction of the estimated life of the alluvial tin deposits of the peninsula.

The U. S. Bureau of Mines' potash well No. 6 being drilled three miles from McCanny in Upton County, Tex., has reached a depth of 1,400 ft., and will be completed within a few days. The drilling probably will go to the bottom of the salt bed, which in that area has a vertical dimension of approximately 1,000 ft. The log of the hole shows a 100 per cent core recovery.

C. K. Leith has completed a brief study of the organization of the economic branch of the Bureau of Mines. He expects to return to Washington, after three weeks in the West Indies, to continue the work.

Childress L. & Z. Acquires New Properties

ANNOUNCEMENT was recently made by the Childress Lead & Zinc Company of the purchase of the interests of R. L. Kidner in the Tri-State district. Mr. Kidner was part owner of the South Side and the Fox mines. The Childress company also recently acquired the Northern mine of the Commonwealth Mining Company. Frank Childress, president of the company that bears his name, justified the purchase of these properties and demonstrated his faith in the future of the Joplin district, by stating: "As soon as the majority of the companies of the field decide that there is only a demand for so much ore, they will not persist in producing more than this amount and thereby ruining ore prices."

4,300-Ft. Tunnel to Drain Morenci Mines

Gravity drainage of the mines of the Morenci district, of Arizona, is to be made possible through the driving of a 4,300-ft. tunnel, contract for which has been let by the Phelps Dodge Corporation to Reed Roberts. Work on the project is to be started immediately in order to have it ready for service before the end of the year. Outlet of the tunnel will be at a point on Chase Creek above Clifton, a short distance from the old Longfellow incline. Work will be conducted from the outlet end, and three shifts will be employed. The tunnel will be 7½ ft. high and 6 ft. wide, although a smaller size would be sufficient to handle the flow of water. The grade will be about ¼ of 1 per cent, and the terminal will be at a point 200 ft. below the 1,400 level of the No. 46 shaft of the Humboldt mine. This level is the lowest level at present being worked.

United Verde Adds to Clarkdale Smelter

United Verde Copper Company is building a foundry at its smelter in Clarkdale. The new plant will contain a steel furnace, a brass furnace and an annealing furnace, all electrically operated. Power is to be generated by means of waste heat from the reverberatories. The building will be 80 ft. by 100 ft. Ordinary steel material now being purchased on the Pacific Coast will be made in the local plant, and much material that has been made of iron will now be constructed of steel. The cost for these improvements is estimated at $100,000.

Ludlum Engineering to Dredge Oregon Holdings

The Ludlum Engineering Corporation of New York City, which took options on 2,000 acres of dredge ground on Foots Creek, 6 miles below Gold Hill, Ore., early last year, and recently took over the holdings, has begun active operations in equipping the property with a modern electrically driven dredge.

Premier Gold Acquires Silverado Group

Obtains Control in Return for Development and Equipment of B. C. Property

CONTROL of the Silverado group has been acquired by the Premier Gold Mining Company, and the Silverado Consolidated Mines is to be formed with a capitalization of 1,000,000 shares at $1 par, of which the Premier company is to have 550,000 shares and Silverado Mines—the present owner—will retain the remainder. The Premier company will pay the Silverado company $50,000, which, however, is to be returned to the Premier company out of earnings, but which will not be a charge against the assets of the new company and must not be paid out of such assets. The Premier company is to start at once on the development and equipment of the Silverado group of claims. For the money it expends in this work it will receive the 550,000 shares in the new company.

The Silverado group is situated near the Prosperity group, on 76 per cent of which the Premier company holds an option and which it is developing in the Portland Canal division. Silverado is on the west side of the mountain and Prosperity on the east. It is understood that the Premier company intends to drive a tunnel through the apex of the mountain to develop the two properties and to serve as a main haulage tunnel. Late last fall, four new veins were opened on the Silverado. Shipment of 15 tons to the Selby smelter, on San Francisco Bay, brought a return of more than $100 per ton in silver, gold, and lead.

With the approval of Justice W. A Macdonald, of the Supreme Court of British Columbia, the famous old Bullion mine, in the Cariboo district, has been sold to the Revenue Mining Company for $250,000. The Revenue company has been developing a lode-gold property near Prince Rupert for more than a year. More recently, it has acquired several properties in the Kootenay. Most of the stock of the company is owned in the United States. The Bullion mine was under option to a syndicate closely connected with Canadian Pacific Railway and controlled by Guggenheim interests. For the last twenty years it has been in litigation; hence the need of the court's consent to the sale.

The General Exploration Company and associates, of Vancouver, have acquired a controlling interest in the Bayview group, situated near Stewart, in the Portland Canal division. They have paid off all indebtedness, and provided funds for necessary equipment, including an aërial tramway. A considerable amount of exploration has been done on the property by different parties, and engineers' reports state that 400 to 500 tons of shipping silver-lead ore is available for transportation as soon as a tramway has been erected.

Idaho Maryland Crosscut Opens New Vein

Discovery Is Made on 1,900 Level—Numerous Purchases of Property Mark California Activities

AN IMPORTANT oreshoot has been cut upon the 1,900 level of the Idaho Maryland mine, at Grass Valley, Calif. The new strike was intersected by a crosscut 450 ft. from the footwall of the main Idaho vein and is to the north of this vein. It is 6 to 8 ft. thick and has been drifted 50 ft. in both directions, with an exposure of 100 ft. in length. Apparently the same vein was cut upon the 2,000 level, but difficulties in handling the ore stopped raising operations at this level. A small vein was cut upon the 1,950 level. This was believed to be the same vein that had been cut upon the 2,000 level, but it is now known to be some 20 ft. distant from the new vein, the discovery of which has greatly improved the status of the Idaho Maryland.

C. A. Brockington has taken over the Gold Center mine, at Grass Valley, Calif., under bond and lease. Plans are being made to reopen the property. The Boundary property, at Grass Valley, has started milling operations. Additional electrical equipment has been installed at the Murchie mine, near Nevada City, and preparations are being made to operate the five-stamp mill upon the property. Deer Creek Placer Mines Company is preparing to resume its operations below Nevada City on Deer Creek.

Comanche Mining & Production Company, at Blind Springs Hill, Benton, Calif., is rapidly completing its major development. The Ross tunnel is now 4,325 ft. in length and has less than 50 ft. to go to reach the estimated intersection of one of the important veins opened up by a 1,000-ft. shaft.

The Hammond Engineering Company has acquired the Too Handy mining property east of Marysville, Calif., and has rehabilitated the shaft and equipped it for underground exploration. Fifteen men are now employed.

Permission to sell stock has been given to the Twin Sisters Mining Company, which controls claims on the north side of the Middle Yuba River, about 24 miles northeast of Nevada City. The company is planning to drive a 1,000-ft. crosscut tunnel.

The Alleghany-El Dorado Mining Company is operating the El Dorado and Yellow Jacket claims, at Alleghany, and milling is expected to being at an early date.

Application has been made by the Mirable Park Association, of Lake County, for water-diversion rights to facilitate operations of a quicksilver prospect in southern Lake County.

C. M. Bland and C. C. Fiske have sold their interest in the Bell Cow group of claims, in Arbuckle Basin, to S. H. Fiske, of Redding. California Zinc Company recently installed a compressor at its Winthrop mine and additional men have been placed at work in the mine.

Sale of the Alpha Quicksilver property, in Lake County, for $27,000 under a deed of trust, is announced. J. Smith, one of the principals in an overdue note of $14,000, was the purchaser.

The new California-Tonopah Company has acquired a group of claims near the Defender mine, in Amador County, and plans are under way to dewater the shallow shaft and open up the property.

Still another purchase was made by L. C. Geddes, of San Francisco. He acquired the Vandalia mine, 4 miles south of Shingle Springs, Calif., under lease and bond.

Bolivia May Aid Mining Development

Bolivia has under consideration plans to encourage prospecting and development along the great tin belt, extending from the eastern shores of Lake Titicaca on the north, to the Argentine border on the south. Among the measures being studied are the mapping of the mineral belts by aërial photograhy, and taxation modifications to improve conditions for the small miner.

Considerable interest has been shown in alluvial tin deposits during the past years. At Uncia, an extensive deposit is being drilled. Results to date indicate a sufficient quantity of material with workable values to justify the installation of a large dredge.

New Receiver for Idaho Copper

Judge B. S. Varian, of the seventh judicial district of Idaho, has removed Carey H. Nixon, of Boise, as receiver of the Idaho Copper Company, and appointed Edwin Snow, of the same city, to act in that capacity.

Eastern Capital Exploits California Tin Prospect

Virginia and New York manufacturing interests are reported to have financed an organization known as the American Tin Corporation to develop the Temescal tin prospect in the San Jacinto Mountains, southwest of Riverside, Calif. Jay Tuttle, Jr., is in charge of operations at the property. Some thirty men are employed in the mine development work and several are engaged in metallurgical research.

The Temescal property was operated for a number of years between 1880 and 1900 by English interests, and some tin was produced. A number of veins occur in the granite, although the early production was entirely from one vein, the "Cojalco."

A descriptive article, "Early Tin Mining in California" by H. E. West, relating early operation details at this property, was published in Vol. 117, *E. & M. J.-P.* for Jan. 12, 1924.

Mile-Long Tunnel Driven in Eight Months

Mechanical Mucker and Storage Battery Locomotive Establish Notable Record

SUPERIORITY of mechanical mucking methods has again been proved at the Compañia Minera de Peñolos, S. A., Mapimi, Durango, Mexico, where a crew of picked foremen from the Tintic Standard mine, of Eureka, Utah, and Mexican and Italian laborers headed by Superintendent George Hezzelwood drove in less than eight months 5,412 ft. of 8x9 ft tunnel, averaging 714 ft. monthly, and during one month established a record of 1,001 ft. Costs, though not completed, indicated from daily reports, will not exceed $20 a linear foot, including a complete "write-off" for equipment, with no credit for salvage.

The machinery was started June 1. 1927, after driving 306 ft. open cut. From Jan. 1 to Jan. 3, when the tunnel holed through, 101 ft. of advance was made. The best day's progress amounted to 42 ft. Electric power was used. Air was supplied by an Ingersoll-Rand compressor. A No. 7 Root positive-pressure blower was employed. Ingersoll-Rand drill equipment, consisting of "N" 72 drifters mounted on a special carriage, did the drilling. Hauling was done by a Mancha 2½ ton, Type "B" storage-battery locomtive, with an extra storage-battery and charging unit. Cars of the rocker dump type having a capacity of 40 cubic feet were used.

Mr. Hezzelwood and L. J. Sundeen, one of the Tintic Standard foremen, remain at Mapimi, where they have contracts for driving four drifts, sinking four shafts, and cutting two stations.

Anaconda Company to Use Gas at Great Falls

According to a contract entered into by J. R. Hobbins, vice-president and manager of all the Montana operations of the Anaconda Copper Mining Company and its subsidiaries, and the Montana Cities Gas Company, the Great Falls plant of the Anaconda company will be equipped to use natural gas instead of coal and oil. It will cost $100,000 to change equipment, and, at the rate of present operations, Anaconda will use about 6,000,000 cu.ft. of natural gas a day. Gas is being transported from the Kevin-Sunburst field, about 120 miles from Great Falls, by the Hope Engineering Company, which also will furnish gas for domestic purposes to the city of Great Falls.

Form New Copper Company

A corporation with $500,000 capital will be formed by Missouri and Oklahoma mining men to take over the Sutton copper mines near Eminence, Mo. Several cars of ore were moved from the property during the past month.

Airplane view of the International Smelting Company's plant at Tooele, Utah

International Smelting Company Transforms Dying Enterprise Into Revenue Maker

Anaconda Subsidiary, at Tooele, Utah, Under Direction of J. O. Elton, Salvages Initial Investment of $10,000,000 *and, With Modern Metallurgy and Management, Brings Prosperity to the District*

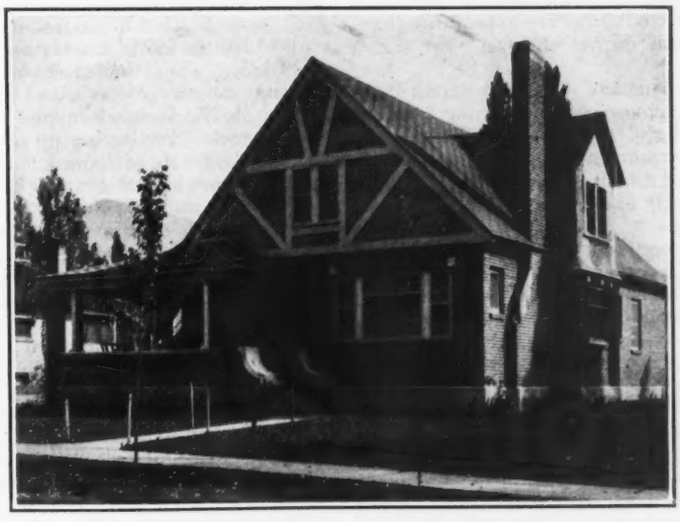
By Gail Martin
Special Salt Lake City Correspondent

SIX years ago, the directors of the Anaconda Copper Mining Company were faced with the choice of either shutting down the plant of the International Smelting Company at Tooele, Utah, and writing off as a loss a $10,000,000 investment or of resurrecting a dying enterprise and transforming it into a revenue maker. Fortunately, the second alternative was decided upon and, equally as fortunate, J. O. Elton was appointed manager of the International Smelting Company.

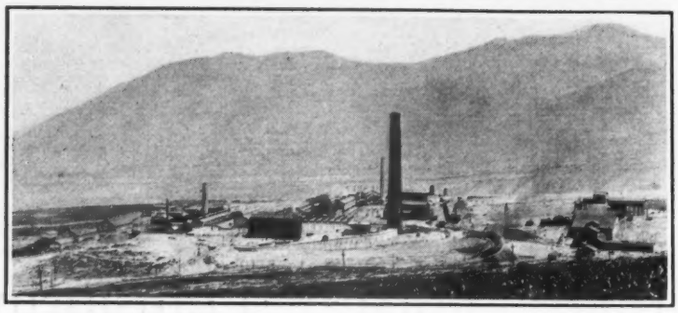
Activities at the International plant at Tooele have been expanded many-fold. In 1924 the company, operating two and three blast furnaces alternately, produced 38,000 tons of lead bullion annually. It operated no mill and no mines. Today, the Tooele flotation plant of the International is treating 1,200 tons daily of lead-zinc ores, and producing about 125 tons of high-grade lead concentrate, 160 tons of zinc concentrate, and 140 tons of iron concentrate.

The Tooele plant now treats annually 735,000 tons of ore, produces 72,000 tons of lead bullion, 10,000 tons of blister copper, and 50,000 tons of zinc concentrates. From these products, about 9,000,000 oz. of silver are recovered. Through its allied smelting and mining operations, the company expends in Utah about $20,000,000 annually, buys $15,000,000 of ore, employs nearly 2,000 men in its combined operations and operates mines in the Bingham and Tintic districts of Utah and mines and a 250-ton flotation plant at Rico, Colorado. Not only has the lead output of Utah been doubled and the zinc output increased several times since the International and other companies undertook the treatment of lead-zinc ores, but Utah miners are receiving, in increased revenues from zinc production alone, $5,000,000 a year, as well as saving large sums formerly exacted in the form of penalties for zinc.

To solve mining and milling problems, the company has developed substantial technical departments, both geological and metallurgical, the services of which are available without cost to customers. Notwithstanding that major problems were solved at great expense, smelting



General superintendent's house erected as part of community betterment plan



Above—Employees' homes at Tooele; part of building campaign of International Smelting Company.
Below—The International smelter at Tooele; mill in foreground.

costs have been reduced to a level that has made possible the lowest treatment rates in the history of the Utah mining industry.

"Home"-Housing Development

Believing that satisfied and loyal employees are the best assets a company can possess, the International has made a noteworthy advance in the solution of the housing problem at Tooele. A building association was formed and money loaned to employees at 6 per cent. Thirteen modern brick cottages were built in various parts of the town. As a result of this movement, 60 or 70 homes, embodying the latest ideas in sanitation, comfort, and attractive appearance, have been built during the last year and a half.

The company has also assisted in the financing of a hotel costing $125,000 to build and furnish. Under a plan of easy payments, an employee can become owner of a home in nine years at a cost not greatly exceeding the sum expended for rent.

A protective clause provides that in case of permanent shutdown of the smelter or the death of the purchaser, the contractor or his estate is repaid by the association all he has put into the house excepting interest money.

The company and J. O. Elton are not resting upon their laurels. Having reared a monument that testifies to the fairness, enterprise, and ability of both manager and organization, new plans are being made that point to an expansion of mining, milling, and smelting operations, to a perpetuation of the Utah and intermountain non-ferrous metal mining, and to an increase of the prosperity of not alone the mining industry but that of farming, banking, manufacturing, the railroads and of local business men as well.

Mohawk Establishes Low Cost Record in 1927

Calumet & Hecla Expects to Complete Draining of Old Cliff Shafts in About Three Months

NOT ONLY was 1927 a banner year for Mohawk, in the Michigan copper district, but it also marked the establishment of a low cost record. Costs were 1c. a lb. lower than for 1926, or a little over 8c. The 1926 costs were 9.172c. With Mohawk's ability to maintain production this year, 1928 should see a decided increase in earnings. The average price of copper in 1927 was 12.92c. a lb. as compared with 13.79c. in 1926. Copper metal now is 14.125c., which increases Mohawk's earning capacity more than 1c. a lb. During 1927, Mohawk milled 759,000 tons of rock. Production up to Dec. 1 was 20,183,000 lb. of refined copper and December production brought the total for the year up to 22,000,000 lb. With a continuance of the favorable labor situation, it is probable that No. 5 shaft, in which a large tonnage of good stamp rock remains, will be reopened this year. Mohawk's program of construction has been completed and its mine and mill plants are now thoroughly modern. The regrinding units in the mill are saving more than a pound of copper per ton of rock stamped. Mine openings are being kept well in advance and a steady flow of rock to the mill is assured.

Calumet & Hecla Consolidated will complete the draining of the Old Cliff shafts in 90 days, it is estimated. This will make it possible to start work of an exploratory character in the spring. It will take longer to drain the old Phoenix shafts on account of the depth and extent of the openings in upper levels. This work is now being pushed with one electric and two Cameron pumps, the latter being lowered as the water level drops. Operations in the conglomerate branches of the company are being increased and production from this source is now the largest in several years.

The Tamarack Junior territory is now being reached through the Red Jacket shaft, and North Tamarack ground will be mined through No. 4, Calumet, as this shaft is opened below the 81 haulage tunnel and drifts are extended. Pillar mining is proceeding in No. 2, Calumet, and Nos. 6, 7, and 9, Hecla. Pillars, arches, and backs of old stopes are being mined. This work will take a long time, inasmuch as the pillars are from 90 to 185 ft. thick and contain much rock rich in copper. With the ultimate abandonment of these shafts above the haulage level, mining will proceed below the 81 through No. 4 shaft, Calumet, and No. 7, Hecla, hoisting of the ore being done through the Red Jacket shaft.

A fire broke out recently at the 39 level of No. 5, Calumet, shaft, but it was extinguished with chemicals. The damage was small and quickly repaired. The fire was caused by a short circuit. In this same shaft, a skip rope broke recently, dropping the skip 900 ft. down the shaft. The skip kept to the rails, however, and did no damage. The shaft was clear at the time, as the company's rule is that no man must be in the shaft while the skips are in operation.

A series of air blasts occurring periodically for two or three days has slowed up the work of repairing Quincy No. 2 shaft. While no damage was done by the blasts, no men were permitted to work until the disturbances subsided. One particularly severe blast shook the district. The cause of the blasts is a mystery. Some authorities contend that the blasts do not originate in Quincy, but are slight earthquakes, due to a slippage on the strata.

Quincy Without Production From No. 2 Shaft

Quincy will be without production from its No. 2 shaft, which was its principal producer, for some time. It may take the greater part of the year to repair the shaft, which was damaged by fire and cave-ins last year. This work is being pushed with all possible speed, however. Three timber shifts are employed. Retimbering now is proceeding between the 42 and 43 levels. It will be slow work for the next 400 or 500 ft. owing to the amount of rock which has fallen into the shaft. The fire originated at the 53 level, below which point the shaft is in good condition.

Quincy is now working No. 6 shaft, from which it is hoisting a good volume of rich ore. It also has No. 8 shaft in reserve. There is a possibility that this unit may be reopened this year, which would enable a return to almost normal production.

London Letter

By W. A. Doman
Special Correspondent

Rhodesia Broken Hill Plant to Produce 1,650 Tons of Zinc Monthly

London, Jan. 24.—Rhodesian base-metal companies, their position and prospects, have been the principal topics of conversation during the last week. It has been suggested that the great Mulungushi water scheme of Rhodesia Broken Hill is not yet a complete success, though there is no reason why it should not develop into one. A cablegram states that the zinc plant is running, and is expected to produce 1,100 tons of slab zinc by March 1; 1,380 tons monthly thereafter, and gradually increase to 1,650 tons. The expenditure has been heavy, and the company, it is said, will soon be in need of additional funds. Whether the undertaking will have to be reconstructed, as has been suggested privately, remains to be seen. I have heard that the Anglo-French Exploration Company was invited to join in working the mine, and declined. Professor Lawn, I am also told, has visited the property, but no report of his has as yet been published. It is generally believed that Rhodesia Broken Hill will eventually become one of the great mines of Africa.

Bwana M'Kubwa has in preparation a scheme for raising £1,000,000 on debentures which will be privately placed. They carry interest at 7½ per cent. These debentures are convertible into shares at par—5s.—and calls will be given to those who put up the money for a term of years at 10s. and 15s. Should these calls ever be exercised, shareholders will get a better price than they have had reason to expect.

Tin has recovered to £254 per ton, and the share market is in a much healthier condition. Leading authorities scout the idea of a famine in the metal.

LEWIS LAZARUS & SONS in their metal market review of 1927, issued a few days ago, state that though copper production in the Old World is increasing, that of the United States is diminishing, and as stocks of rough copper in the United Kingdom become scarcer, so will their value become greater, and the margin between standard and electrolytic copper become narrower. This will enable the Old World to compete advantageously with American refineries for the independent supply of the metal, much of which comes from the British dominions. The price at present is 14c. but Messrs. Lewis Lazarus & Sons predicts a rise in electrolytic to the 15c. level during 1928. Even better prices may yet be seen.

I learn that British interests have acquired 80 per cent of the shares of the Bor Copper Mines from a Franco-Belgian group. These mines constitute one of the largest copper properties in Europe, the annual output being 8,000,000 kilos of copper.

Whether the directors of the London Metal Exchange look forward to more active dealings in metals is not quite clear, but they have issued a notice to the effect that there will be an afternoon 'Change from 3:45 to 4:15 p.m. on every day except Saturday and Bank Holidays, commencing March 5.

The Lake View & Star (Western Australia) announces that its Chaffers lease will be operated by drives in the Golden Horseshoe property that are being extended into it. It is believed that the Boulder and Horseshoe lodes traverse the Chaffers area. To sink a shaft would cost about £50,000, so that the new arrangement will effect considerable economies.

Platinum shares have recently received greater attention, in the belief that the process invented by the Chemical & Metallurgical Company will greatly improve extraction.

Johannesburg Letter

By John Watson
Special Correspondent

Estimate Record Production of Gold for Transvaal During 1927

Johannesburg, Dec. 31—Analysis of gold production in November, 1927, as issued recently by the Transvaal Chamber of Mines, shows that the total for 1927 is likely to be more than ten million ounces. This would constitute a record production for the Rand. The grade of ore treated in the first eleven months of 1927 averaged 6.714 dwt. per ton, compared to 6.543 dwt. in the corresponding period in 1926. Output for November amounted to 848,059 oz. with a value of £3,602,326. This shows a decrease of 7,684 oz. with a value of £32,640 from the output of October.

Lupaard's Vlei gold mine, near Krugersdorp, is controlled largely from London, with the assistance of a local committee in Johannesburg. The management of the property has recently been taken over by N. C. Krone, for some time underground manager and acting general manager on the Nourse Mines. On the advice of the company's consulting engineer, V. G. Ferris, the directors have engaged J. R. Thurlow, one of the metallurgists of the Corner House staff, to investigate and report on the system of metallurgical practice at Lupaard's Vlei.

Native labor returns show 188,879 "boys" working on the Rand gold mines on Nov. 30, an increase of 854 compared with Oct. 31.

Southern Rhodesia mineral output during October follows: Gold, £197,501; silver, £862; coal, £15,670; chrome ore, £8,117; asbestos, £40,085; mica, £2,827; a total value of £285,062 for the month.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Hudson Bay Shares Selling High—Pawnee Strikes Good Ore at 750 Ft.

Toronto, Jan. 28.—Hudson Bay Mining & Smelting Company stock has met with a remarkable reception. Shares which were originally offered at $15 sold for $22 within a few days. A statement, issued by the Mining Corporation of Canada, advised shareholders that of the total of 2,500,000 shares, 1,000,000 shares were being issued for the property. Mining Corporation is receiving and keeping in its treasury 150,000 shares. Of the 1,500,000 shares sold for the financing of the company, Mining Corporation has purchased a large amount, which it proposes to hold as an investment. The only distribution of shares being made is a private one to investors at $15 a share.

Work on the 400 level of the Bidgood property is giving satisfactory results. Assays are not as high as on the 300 level, but it is believed that work on the lower level is too far to the east and that better results will be obtained toward the west. A crosscut is being run to the vein on the 600 level, but it will be about a month before the vein is cut.

Pawnee Kirkland has its main vein cut on the 750 level, where the east and west faces averaged $16.12 and $6.61 a ton, respectively, across a width of 38 in. It is expected that the shaft will be sunk to the 1,000 level.

It is understood that the Laval-Quebec Company, controlling several properties in the Rouyn district, has decided to discontinue further work in that section and to take an option on some copper-gold properties on the Soo line southwest of Sudbury. Sudbury Basin recently took an option on the Cheney copper property still further to the southwest.

KIRKLAND Lake Gold announces that its shaft is now down below the 2,725 level, where a station is being cut. The mill is producing about $40,000 a month, from which a profit of $10,000 to $15,000 is being realized. When the mill started, a little over a year ago, the company had very little cash on hand, but now its assets are approximately $200,000.

During December the mill of the Central Manitoba Mines treated 3,100 tons of ore, averaging $7.75. A good deal of trouble was experienced in obtaining satisfactory extraction because of the presence of organic matter in the water supply, but this difficulty has now been overcome. At present the grade varies between $15 and $16 a ton, but this is not expected to last. An average of $10 to $11 is estimated to be much nearer normal gold content.

Book Review

An Exposition of Progress in Terms of Flow of Consumer Income

THE ROAD TO PLENTY. William T. Foster and Waddill Catchings. No. 11 of the publications of the Pollak Foundation for Economic Research. Published by Houghton Mifflin Company, Boston and New York. Price $2.

OVERPRODUCTION, underconsumption, lack of markets—what is the cause and the remedy for the condition characterized by these terms, all of which are different names for "the plight of business without a buyer"? No satisfactory answer is found in the automatic production-consumption theory, according to the authors. This classic theory of economists that "production is all," that it automatically finances consumption, that the business man may therefore devote his full attention to production, does not square with business facts, they say through the mouths of the characters in their book.

"Under present conditions business is certain to get well started either up or down, and either way the end is hard times. Corrective influences do not automatically restore the equilibrium, except far too slowly and at the tragic cost of human suffering. No matter which way business is headed, all forces combine to accelerate the movement. There is not an even chance that either inflation or deflation, once well under way, will be stopped in time, without more effective effort to stop it than we have made in the past."

"The Road to Plenty" is not merely an exposition of an economic plan for correcting these conditions. It is also a sermon on poverty and the unemployed and on the duty of society to bring about a change. It will disturb, let us hope, the smug complacency of those individuals who, in comfortable circumstances themselves, accept as unavoidable that large numbers of their fellowmen should have insufficient income or none at all. "Any economic system is intolerable which denies to willing workers a chance to work," the Little Gray Man muses. "What gets me is that with all our boasted prosperity so many people still suffer from want and anxiety."

Of course, the answer, as might be expected, is, "insufficiency of consumer income," affecting business and worker alike. The right flow of money to consumers is the chief need. The Business Man tells how to secure it: "We must provide as effectively for financing consumption in the future as we have provided for financing production in the past. . . . We cannot increase the standard of living without increasing the volume of money *at the right rate*." Progress can only come, he summarizes, when there is the right flow of money to consumers. The flow is not right unless in some way the shortage due to corporate and individual savings is made up, and unless there is, in addition, a sufficient flow of new money to bring about the distribution of a constantly increasing output. . . . "Incredible as it may seem, we have no mechanism for bringing about the needed increase," he says.

"Was not the Federal Reserve System established for that very purpose?" asks the Lawyer.

"No. It was established to provide *producers* with money, and it does that admirably."

No agency has ever been set up for bringing about the right flow of money to the people, the Business Man goes on to explain, for the reason that economic teaching has always declared that no such agency is needed, since as long as producers get enough money, consumers must automatically get enough.

Establishment of the desired agency in the form of a separate federal board is proposed by the Business Man; a board which will itself gather and measure the data best adapted to show the adequacy of the flow of consumer income, using, however, for its own purposes the wealth of data gathered by other agencies. Having thus collected the needed information, the board will advise the government how to use it as a guide in all fiscal matters. The board itself, guided in the same way, will determine when certain expenditures are to be made, which already have been provided for by Congress, under a policy of long-range planning of public works. Thus the board, through both its own acts and its published reason for its acts, will provide business with the needed leadership. Further, if indexes ever show the need of a reinforced consumer demand, the board must have the power to bring about such expenditures out of funds previously accumulated for the purpose, or out of loans which involve an expansion of bank credit.

The proposed plan, it is declared, would give the government no new powers, but provide merely for the more intelligent use of its present powers in such a way as to increase human happiness everywhere.

A happy style has been adopted by the authors for presenting their stimulating ideas. The reader will find his time well spent. A. H. HUBBELL.

GASES FROM BLASTING—"Gases from Blasting in Tunnels and Metal-Mine Drifts" is the title of Bulletin 287, issued by the U. S. Bureau of Mines (price 20c.). In co-operation with mining companies of the Southwest, the Bureau has been endeavoring to ascertain the latest and most economical explosives for use in metal mines and to determine the best methods of blasting under various conditions. Bulletin 287 contains the results of one investigation thus made, which has involved the comparison of the composition and quantities of the gaseous products of various explosives and the ascertaining of the effect of different methods of loading holes on the relative amount of poisonous gases produced. The authors are E. D. Gardner, S. P. Howell, and G. W. Jones. The bulletin contains 96 pages.

GEOPHYSICS—The report on geophysical methods of prospecting, which the U. S. Bureau of Mines has been working on since the spring of 1927, has made its appearance. It is entitled "Geophysical Methods of Prospecting." The authors are A. S. Eve and D. A. Keys. It contains only 26 pages, the treatment of the subject being confined by the authors to a brief and elementary account of the principles involved in the various methods.

The report, to use its own words, is written for geologists, mining engineers, and others who desire a concise and simple explanation of the more important physical principles underlying each of the various methods of geophysical prospecting that are being applied by scientific institutions and private companies. The methods described are based on recognized physical principles, but the interpretation of the results obtained from such surveys depends on the knowledge and experience of the geologists and physicists consulted. The authors then state: "The best methods to use at any particular place will depend upon the geological structure of the region and the type of mineralization one is looking for. Experience will be an important factor in reaching a decision. The reader should note that geophysical methods of prospecting are in reality an aid to the geologist in supplementing his knowledge, and are in no way a substitute." Of the 26 pages, 4 are devoted to magnetic methods, 5 to gravitational methods, 15 to electrical methods, and 2 to seismic methods. Twenty-six illustrations are used, the diagrams covering simple theoretical cases.

In conclusion, the authors say, "The statement may be made without hesitation that all the methods under review are based on rational and scientific study; they use definite physical principles which are known, and, broadly speaking, understood. Thus they have nothing in common with the divining rod or 'doodle bug,' which is not rational, not scientific, and not based on physical principles that are either known or understood."

This pamphlet will be a valuable aid to those who desire an elementary knowledge of geophysical methods, especially those who have found the existing technical literature on the subject difficult to understand. The price of this bulletin (Technical Paper 420) is 10c. per copy. It is sold only by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

PYRITE—A monograph, in two volumes, on the world's resources in pyrite has been received from the secretary of

the Geological Institute of Spain. This is published under the auspices of the XIVth International Geological Congress of Spain by international agreement. Technical and industrial facts regarding the principal pyrite deposits of the world are given. The price of the two volumes is 50 pesetas, plus 2 pesetas for postage to Portugal and the United States and 10 pesetas extra to other foreign countries.

GEOLOGY—*Economic Geology* for January-February, 1928, contains a 44-page article entitled "The Guanajuato Mining District, Mexico," by Alfred Wandke and Juan Martinez. The geology of the ore deposits is the principal theme. The paper concludes with a three-page description of local mining and milling methods. In same issue is a short article entitled "A Genetic Comparison of Michigan and Bolivian Copper Deposits," by J. T. Singewald, Jr.

ZINC, PHOSPHATE — Two more advance chapters of "Mineral Resources of the United States, 1926," have been received. These are, respectively, "Zinc in 1926 (Smelter Report)," by Amy Stoll; and "Phosphate Rock in 1926," which is unsigned. Both bulletins are sold at 5c. a copy by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

INDIA, MINING—The Annual Report of the Chief Inspector of Mines in India for 1926 has been issued at Calcutta. The price is 4s. 9d. The report contains 176 pages and gives a large mass of statistical data regarding mines, minerals and accidents. These are for British India only, in conformity with the Indian Mines Act for 1923.

PUMPING—The *South African Mining and Engineering Journal* for Dec. 10, 1927, contains an article by A. L. Egan, describing a new mine pump. This pump, which is termed a "rocking" pump, has no floats, and the air valve is positively operated by the movement of the contained water about the rocking axis or by a pendulum action.

COPPER SMELTING — "Suggested Improvements for Smelting Copper in the Reverberatory Furnace" is the title of Technical Publication No. 49, issued by the A.I.M.E. This paper is to be discussed at the February meeting. The authors are G. L. Oldright and F. W. Schroeder.

MINING, PERU — Metal mining data and statistics of the industry in Peru for 1925 have been published by the Ministerio de Fomento at Lima. The title of the publication is "Movimiento Económico de la Industria Minera del Perú en 1925, Part I, Metal Mines." It contains 200 pages.

TANTALUM, TIN—Deposits of tin and tantalum in Pilbara, Western Australia, are discribed by Edward S. Simpson in the issue of Dec. 5, 1927, of the *Chemical Engineering and Mining Review*, of Melbourne.

LIME — The Bureau of Standards, U. S. Department of Commerce, has issued a 104-page pamphlet entitled "Manufacture of Lime." This is Circular No. 337. It is sold at 45c. a copy by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

ZINC—The November-December issue of *Zn*, the official bulletin of the American Zinc Institute, contains a 6-page article by C. E. Siebenthal discussing the subshale map of the area underlying the Cherokee shale in the region between Cardin and Commerce, in the Picher district, Oklahoma.

POWER SHOVELS—R. W. McNeill, of the Westinghouse Electric & Manufacturing Company, is the author of an article entitled "Electric or Steam Power Shovels?" which began in the Nov. 16 issue of the *Mining and Industrial Magazine of South Africa.*

PHOSPHATE—Bulletin 795G of the U. S. Geological Survey is entitled "Phosphate Rock in the Three Forks-Yellowstone Park Region, Montana." The authors are D. Dale Condit, E. H. Finch, and J. T. Pardee. Pages 63, illustrated.

WATER TREATMENT—Victor T. Edquist has an article describing boiler-water treatment at the Sons of Gwalia mine, Western Australia, accompanying the December *Bulletin* of the Institution of Mining and Metallurgy.

NON-METALLIC MINERALS—The Industrial Development Board of Manitoba has issued a 94-page bulletin on the non-metallic mineral resources of the province. R. C. Wallace and L. Greer are the authors.

MINING, CANADA—The report of the Dominion Bureau of Statistics on the mineral production of Canada during 1925 has been issued. Its price per copy is 50c.

ASBESTOS—J. G. Ross, of Montreal, is preparing a monograph on asbestos for the Dominion Department of Mines.

PATENTS

ANTIMONY. Nos. 1,654,527-8, Jan. 3, 1928. H. M. Burkey, assignor to American Metal Company.

A process of producing metallic antimony and alloys of antimony and alkali metal arsenates.

VANADIUM. No. 1,654,820, Jan. 3, 1928. H. T. Koenig, Denver, Colo.

A process of treating vanadiferous ores and compounds by roasting them with sodium chloride and an acid.

ROCK DRILL. No. 1,654,833, Jan. 3, 1828. J. V. Rice, Jr., assignor to Fred E. Tasker, New York.

A gasoline driven rock-drill.

AIR RECEIVER. No. 1,655,107. Jan. 3, 1928. William Prellwitz, assignor to Ingersoll-Rand Company.

ROCK DRILL. No. 1,656,301. Jan. 17, 1928. E. W. Stevens, assignor to Chicago Pneumatic Tool Company.

A spring handle for drills.

COPPER METALLURGY. No. 1,654,930, Jan. 3, 1928. William E. Greenawalt, Denver, Colo.

In the deposition of copper from solutions obtained from leaching copper ore and containing salts of iron, the process comprising the following: electrolyzing the solution, treating the electrolyzed solution with sulphur dioxide, then treating the solution with hydrogen sulphide, and then again electrolyzing the solution.

GEOPHYSICS—No. 1,652,227. Dec. 13, 1927. Theodore Zuschlag, assignor to the Taumac Corporation, New York.

A method of investigating subterranean strata by setting up an antenna in a drill hole or the like, causing high frequency oscillations in said antenna, varying the frequency of the oscillations, and ascertaining the resistance characteristic of the antenna for each frequency employed.

DRILL BIT—No. 1,652,578. Dec. 13, 1927. G. F. Nevin and John Goodland, Jr., Butte, Mont.

An impact rock drill bit with a shank having a central channel, and with several radially disposed cutting edges and other features.

HAT—No. 1,652,776. Dec. 13, 1927. E. N. Galanis, New York.

A miner's cap with a crown so constructed with cushioning media as to afford protection for the head.

WOOD PRESERVATION—No. 1,652,811. Dec. 13, 1927. D. B. Bradner, assignor to E. I. du Pont de Nemours & Company.

A process of treating wood by dissolving arsenic pentasulphide in molten sulphur and impregnating the wood with this solution.

SULPHUR. Nos. 1,656,504-5. Jan. 17, 1928. K. W. Schwab, assignor to Texas Gulf Sulphur Company.

A method of treating sulphur to remove its impurity and to improve its color.

MIXING APPARATUS—No. 1,649,939. Nov. 22, 1927. Frank M. Wichman and Alfred P. Hartlapp, Salt Lake City, assignors to U. S. Smelting, Refining and Mining Company.

A mixing and disintegrating apparatus consisting of a table with a series of plows and cutting disks above it, these being so arranged as to stir and cut the material on the table and to deflect it toward the periphery as the table rotates.

CORE-EXTRACTOR — No. 1,650,017. Nov. 22, 1927. George Irvin Keniston, Long Beach and Charles E. Priestley, Torrance, Calif., assignors to Cyrus Bell, and C. B. Wrightsman.

A device for extracting a core from a core barrel.

TUNNELING — No. 1,650,103. Nov. 22, 1927. Henry M. Watchron, Sapulpa, Okla.

A tunneling device consisting of an auger, a casing, and a means of rotating the auger in one direction and rotating the casing in the opposite; also a means for moving casing, auger and power forward simultaneously.

Personal Notes

WALTER L. MAXSON, who is now with the Allis-Chalmers Company, Milwaukee, Wis., was in New York last week.

RENSSELAER H. TOLL, consulting mining engineer of Long Beach, Calif., is in Inyo County, Calif., examining talc deposits.

J. A. REID, of Toronto, recently made an examination of the San Antone property, in the Rice Lake district of Manitoba.

H. J. STEWART has been elected vice-president and managing director of the Carier-Malartic Gold Mines, Ltd., in the Hurricana area of northern Quebec.

T. W. CAVERS, until recently in charge of the smelter at Concepcion del Oro, Mexico, has accepted a position with the Granby company at Anyox, B. C.

BERT S. BUTLER, of the U. S. Geological Survey, is now in Tucson, Ariz., where he is engaged in delivering a series of lectures to students at the University of Arizona.

CLINTON H. CRANE, president of the St. Joseph Lead Company and of the Mining and Metallurgical Society of America, was recently made a director of the Phelps Dodge Corporation.

DR. E. C. ANDREWS will sail sometime in February from Vancouver, B. C., for his home in Sydney, Australia. Dr. Andrews has been in the United States and Canada for several months.

LINDSAY FOSS, recently of the Dome Mines engineering staff, has been engaged as resident manager of the Kirkland Federal Mines, operating in the Kirkland Lake area of northern Ontario.

Prof. A. F. TAGGART, of Columbia University, inspected metallurgical operations in the Salt Lake valley recently. He also lectured before the department of mining and metallurgy of the University of Utah.

Dean FRANK H. PROBERT, of the college of mining, University of California, was in Salt Lake City recently. He delivered an address on "Science, Engineering, and Industry," before the Engineering Council of Utah.

BROWNLEE B. GAULD, member of the Physical Exploration Corporation (Mason, Slichter & Hay), delivered two lectures on "Physical Methods of Exploration" at the Michigan College of Mining and Technology, Houghton, Mich., on Jan. 26 and 27.

GAR A. ROUSH, formerly on the teaching staff of Lehigh University and the Montana School of Mines, is now making his home at Bethlehem, Pa., whence he is making fortnightly trips to New York in connection with the proposed Museum of the Peaceful Arts.

S. J. KIDDER is now in charge of the Eustis Mining Company's property at Eustis, Capelton, Quebec. The company has shut down the mill. Underground work at present is confined to driving a crosscut to the Albert property.

N. H. GETCHELL, manager for the Betty O'Neal and Gold Circle Consolidated Mining companies, in Nevada, who has been in San Francisco for several weeks on account of ill health, is in Carson City, Nev., to attend a special session of the Legislature, of which he is a member.

LEWIS K. JACOBSEN has been in New York completing arrangements to start for Mount Isa, in Australia, where he will be in charge of the development of flotation practice for the treatment of the complex lead-silver-zinc ore. The Mount Isa company is now controlled

LEWIS K. JACOBSEN

by the Russo-Asiatic group in London, and the selection of Mr. Jacobsen for this important task is recognition of the successful work that he has done in the Rocky Mountain region, particularly at the Utah Apex concentrator in Bingham Canyon, on the selective flotation of lead, zinc, and copper. Mr. Jacobsen sails from Vancouver for Sydney this month.

H. C. HENRIE, head of the labor department of the Phelps Dodge Corporation, Copper Queen branch, has gone to Matahambre, Cuba, where he will do some consulting work on labor problems and safety work for the American Metal Company. The mine is an underground copper property in the Province of Pinar del Rio.

ANDREW M. FAIRLIE, consulting chemical engineer, has been retained by the American Zinc, Lead & Smelting Company to design an extension to the company's sulphuric acid plant at East St. Louis. The extension, according to present plans, will include a new Glover tower and six Mills-Packard water-cooled chambers. Mr. Fairlie resides in Atlanta, Ga.

GEORGE D. YOUNG, of Grant's Pass, Ore., writes explaining that he is not the George Young mentioned in a letter by William H. Hampton that appeared in our issue of Jan. 7. We take this opportunity of giving publicity to Mr. Young's disclaimer of any connection with the misdoings of certain so-called assayers who have succeeded in duping prospectors and others. He explains that he is neither an assayer nor a chemist.

N. O. LAWTON, consulting mining engineer of Salt Lake City for the last six years, has been elected general manager and director of the Copper Hill Mines, Ltd., with properties in the new Rouyn mining district, Province of Quebec, Canada. Mr. Lawton has closed his office in Salt Lake City and left for Montreal to assume the duties of the new position. His main address for the immediate future will be Clericy, P. Q., Canada.

OBITUARY

ARCHIBALD J. MCCLURE, New York mining engineer, died on Feb. 6. He was 54 years old .

H. J. FORD died recently at the Ellerton Gold mine, in the Pietersburg district, northern Transvaal.

E. M. WESTON, veteran mining engineer with experience in Australia and Transvaal mining districts, died recently in Natal. He was at one time professor of mining at the Johannesburg School of Mines.

THOMAS A. MERRITT, vice-president of the Consolidated Coppermines Corporation, died at Duluth, Minn., recently. Mr. Merritt took part in the development of mines, not only in Nevada, where the Consolidated mines are located, but in Oklahoma and Arizona as well. His son, CARLTON MERRITT, is active in the affairs of the Consolidated.

E. C. PECHIN, retired mining engineer, died on Feb. 7 at Buchanan, Va. Mr. Pechin was born on Dec. 9, 1834, in Philadelphia. He graduated from the University of Pennsylvania in 1856, and was, in fact, at his death one of the oldest living graduates of that institution. Although he started his career as lawyer, in 1867 he turned to mining engineering for a livelihood. Among other things, he was the designer of cooling plates for blast furnace boshes. He was one of the original members of the A.I.M.E.

EUGENE BURFORD BRADEN died in San Francisco on Jan. 29, 1928. He was born in Indianapolis. In 1894 he was appointed by President Cleveland as assayer in charge of the U. S. Assay office at Helena, Mont. Mr. Braden came to San Francisco in 1905 from Montana and assumed charge as manager of the Selby Smelter of the American Smelting & Refining Company. He remained in this position until 1925, when he became a member of the advisory board of the company. He has been associated with his company for 29 years. Mr. Braden was 63 years old.

Market and Financial News

Hudson Bay M. & S. Organization Interests Financial Circles

HUDSON BAY Mining & Smelting Company, Ltd., is a Canadian corporation organized to take over the Flin Flon property through ownership of Flin Flon Mines, Ltd., the operating company. Hudson Bay Mining has authorized capitalization of 2,500,000 shares of no par value, all of which will be outstanding after present authorized transactions are completed.

Hudson Bay owns 20,000 shares of Flin Flon stock which, other than for qualifying shares of directors, is all the stock outstanding. It owns no mines or mining leases or property other than the Flin Flon shares.

R. E. Phelan, chief engineer of Flin Flon Mines, Ltd., states in a letter to the Hudson Bay company that "Flin Flon Mines, Ltd., owns mining leases on Dominion lands in The Pas mining district, in northern Manitoba and Saskatchewan, aggregating 5,679 acres, and certain rights on water powers in the same provinces. The principal mining claims are in the vicinity of Flin Flon Lake, which lies approximately 85 miles northeast of the town of The Pas, starting point of the Hudson Bay Railroad.

"The Manitoba Northern Railway, a subsidiary of Canadian National Railways, has agreed to build a railroad from a point on the Hudson Bay Railroad near The Pas to the company's properties at Flin Flon Lake, and construction has started. Flin Flon Mines has contributed $250,000 toward the cost of this railroad to insure its completion during 1928. A freight agreement covering incoming and outgoing freight from points of origin and to points of destination has been made with Canadian National Railways, which will operate the Manitoba Northern Railway under lease.

"There is developed in the company's claims at Flin Flon Lake by shafts and underground workings and by diamond drilling to a depth of 900 ft., 18,000,000 tons of copper-gold-silver-zinc ore. This is a continuous orebody with a length of about half a mile and a maximum width near the surface of 300 ft. Though the width of the orebody has somewhat decreased at the depth stated, there is no diminution in its grade and no indication of its early termination.

"Flin Flon Mines, Ltd., will construct at this property a mine plant, a flotation mill with cyanide annex, a copper smelter and an electrolytic zinc plant, to mine and treat 3,000 tons of ore per day. About one-third of the tonnage will be mined by electric power shovels from an open pit. The company will also build a hydro-electric plant and transmission line to supply its power requirements."

South African Gold Mine Dividend Comparisons

	Dec., 1927	June, 1927	Total 1926
	—Per Cent—		
Rand Mines group			
Rand Mines, Ltd.	50	50	100
Cons. Main Reef	5	6¼	3¾
Crown Mines	35	32½	60
Geldenhuis Deep	2½	...	5
Modder "B"	40	40	80
Modder East	5	...	...
New Modder	65	65	115
Nourse Mines	2½	...	...
Rose Deep	2½	2½	6¼
Barnato group			
Government Areas	45	40	72½
Langlaagte Estate	5	7½	12½
New State Areas	5	7½	15
Van Ryn Deep	20	20	45
Witwatersrand	3¾	3¾	10
Anglo-American group			
Brakpan	25	25	50
Springs	17½	16¼	33¾
West Springs	3¾	6¼	10
New Era	10	10	20
Union Corporation			
Geduld	20	17½	37
Modder Deep	70	65	135½

DECEMBER PRODUCTION from the Dome Mines, in Porcupine, was the highest in the last two years, the total for the month being $400,527, an average recovery of $8.76 a ton. A preliminary estimate of 1927 figures shows a total of 544,000 tons milled and a production of $4,030,000, or an average of $7.40 a ton. This is a decrease of 11,700 tons milled, but an increase of 31c. average recovery per ton and an increase in total production of $190,000. Operating costs were reduced from $4.16 to $4.10 and the net income will amount to $1,975,000, an increase of $190,000 as against dividend requirements of $1,191,667. Net liquid assets are believed to be over $4,000,000.

Copper Consumption

Data recently released by the American Bureau of Metal Statistics show the consumption of copper in some of the important copper-requiring industries of the United States in the fourth quarter of 1927, and in previous quarters. Quarterly estimation as to other important branches of consumption is impossible. The figures follow, in short tons:

1926	Electrical Manufactures	Automobiles	Buildings	Manufactures for Export	Total
First quarter	46,500	26,400	13,300	11,200	97,400
Second quarter	47,500	28,700	11,300	11,150	98,650
Third quarter	52,000	27,900	13,600	15,150	108,650
Fourth quarter	55,000	19,800	12,000	12,400	99,200
Totals	201,000	102,800	50,200	49,900	403,900
1927					
First quarter	45,500	24,100	11,300	12,700	93,600
Second quarter	49,000	28,300	10,700	15,600	103,600
Third quarter	48,000	24,600	12,800	14,200	99,600
Fourth quarter	54,000	17,600	11,300	13,500	96,400
Totals	196,500	94,600	46,100	56,000	393,200

Trail Ore Receipts 547,682 Tons From 116 Mines

THE Consolidated Mining & Smelting Company of Canada has annouced that its metal output during 1927 consisted of 145,521 tons of lead, 73,527 tons of zinc, 9,262 tons of copper, 7,192,607 oz. of silver and 29,490 oz of gold. This compares with a metal production in 1926 of 131,052 tons of lead, 67,546 tons of zinc, 10,632 tons of copper, 7,178,817 oz. of silver, and 50,075 oz. of gold. The sharp decrease in the production of gold in 1927, compared with the previous year, is due to the cessation of production at the company's Rossland gold-copper mines; the decrease, however, has not detrimentally affected the company's profits, as during both 1925 and 1926 the Rossland mines were operated at a loss in the hope that exploration and development might reveal a profitable body of ore.

Besides the large contribution from the Consolidated company's own mines, 116 independent operators shipped to the Trail smelter in 1927. The following table gives the districts in which the mines are situated and the tonnage from each district.

District	Number of Mines	Tons
Ainsworth, Slocan and Lardeau	46	42,219
Boundary	20	33,246
East Kootenay	10	1,394
Nelson and Arrow Lakes	11	19,763
Other districts in British Columbia	19	2,347
State of Washington	10	36,485
Consolidated company's mines	..	412,228
Totals	116	547,682

Owing to the decreases in the prices of silver, lead, and zinc, the independent producers contributed a considerably smaller tonnage than in 1926; the Stemwinder, McAllister, and Silversmith mines, three of the largest shippers in 1926, shipped either nothing or only negligible quantities during last year, and the Lucky Jim and Whitewater mines shipped only small quantities of ore, compared to 1926, as concentrators were being erected at both properties, and only high-grade material was shipped, the low-grade being saved for concentration at the properties. The Consolidated company, on the other hand, made far larger shipments from its properties, the Sullivan mine, of course, being the chief contributor. This is the reason that the silver production has not risen in proportion to the lead. Sullivan ore contains about ½ oz. of silver per unit of lead, whereas the Slocan ores often carry 3 oz. per unit of lead. It will be noticed that the mines in the State of Washington shipped a large tonnage to the smelter. The ores from these mines were chiefly dry silver ores.

STATISTICAL NOTES

MOUNT LYELL MINING & RAILWAY COMPANY, operating copper properties and chemical works in Tasmania, reports dividend payments in 1927 amounting to 2s. 3d. per share.

CALUMET & ARIZONA MINING COMPANY, which, in addition to its mining properties in the Bisbee district, in Arizona, owns 1,229,741 of the 1,800,000 outstanding shares of the New Cornelia Copper Company, reports the following financial results for the third quarter and for the first nine months of 1927:

	Third Quarter	Nine Months
Gross income..	$2,340,808	$7,705,593
Net income, before depreciation and depletion	923,301	2,918,281

DOME MINES, LTD., reports for year ended Dec. 31, 1927, net earnings of $1,960,584 after expenses and taxes, but before depreciation and depletion, comparing with $1,742,759 in 1926. Net earnings for the fourth quarter were $593,361 before depreciation and depletion, compared with $476,111 in the preceding quarter and $428,335 in the last quarter of 1926.

MCINTYRE PORCUPINE MINES, LTD., gold producer in Ontario, reports for the quarter ended Dec. 31, 1927, gross recovery of $1,033,678, comparing with $981,251 in previous quarter and $936,755 in the last quarter of 1926. Net earnings after expenses and taxes, but before depreciation, were $463,231, against $453,836 in the preceding quarter and $401,918 in the final quarter of 1926.

FRONTINO AND BOLIVIA GOLD MINING COMPANY, operating in Colombia, for the year ended June 30, 1927, reports working profit of £33,465 from the treatment of 24,840 tons of ore. Production totaled 27,562 oz. of gold and 20,149 oz. of silver. During the first four months of the current year the average value of the ore has been £5 9s., against £4 16s. in the preceding year. Ore reserves are estimated at 51,100 tons with an average gold content of 18 dwt.

CRESSON CONSOLIDATED GOLD MINING COMPANY reports for quarter ended Dec. 31, 1927, net earnings of $21,717, after expenses, compared with $29,462 in preceding quarter and $156,242 in the fourth quarter of 1926. For the fiscal year ended Aug. 31, 1927, the company reports profit of $304,719 after expenses and taxes, compared with $277,076 in the preceding year, and $774,286 for the year ended Aug. 31, 1925. Total cash on hand at the time was $847,582.

BURMA MINES, LTD., reports the following production from its mines in Upper Burma for the third quarter of 1927: Refined lead, 16,500 tons; fine silver, 1,541,772 oz.; copper matte, 2,571 tons. The tonnage of ore milled was 80,700 and of high-grade ore sent direct to the smelter, 10,206. The following figures are estimates of revenue:

Gross revenue	£750,727
Operating expenditure	482,475
Surplus over working expediture..	268,252
Income and super taxes.....	43,543
Depreciation	58,410
Capital expenditure	9,667

AMERICAN METAL COMPANY stockholders will meet March 8 to vote on a proposed issue of 100,000 shares of 6 per cent cumulative preferred stock. According to plans already formally approved by the directors, the shares are to be of $100 denomination, noncallable and convertible. The purpose of the new issue is to offer holders of the present preferred an opportunity to exchange their shares for new preferred before the present preferred stock is called for retirement, and also to provide additional capital for expansion.

UNITED VERDE COPPER COMPANY, operating in the Jerome district in Arizona, reports income from metal sales during the first eleven months of 1927 as $14,032,000, compared with $17,137,617 during the full year of 1926. Receipts for the eleven months were derived from 90,117,180 lb. of copper, at an average price of 13.0727c. a pound, f.o.b. refinery, with a value of $11,780,712; 2,006,608 oz. of silver at a price of 56.6684c. an ounce, with a value of $1,137,112, and 54,354 oz. of gold, at a price of $20.50 an ounce, or a value of $1,114,266.

UNITED STATES SMELTING, REFINING & MINING COMPANY estimates a gross income for 1927 of $5,800,000, compared with $7,007,905 in 1926. If interest to the amount of $446,000 be deducted, and reserves for depreciation, depletion, and amortization be taken at $2,300,000 instead of $3,483,154 as in 1926, a net income of about $3,000,000 will be shown, just a little more than enough to meet the current dividends. The net income for the first eleven months of the year was $2,699,935, after allowing for interest, taxes, depreciation, depletion, and amortization.

TECK-HUGHES GOLD MINES, LTD., during the fiscal year ended Aug. 31, 1927, produced from its mines in the Kirkland Lake district, Ontario, 114,765 tons of ore, from which $18.35 per ton, or a total of $2,105,545, was recovered. The following table shows operating costs:

	Total	Per Ton
Development and exploration	$185,020.87	$1.61
Mining	412,135.15	3.59
Milling	212,711.29	1.85
General expense.....	155,750.95	1.36
Total of direct charges	$965,618.26	$8.41
Depreciation on fixed plant	136,061.01	1.19
Total of direct and indirect charges....	$1,101,679.27	$9.60

Construction work charged to capital account absorbed $561,091.

NEWMONT MINING CORPORATION, the holding company sponsored by W. B. Thompson, reports a net profit for the year ended Dec. 31, 1927, of $14,650,000 after expenses, federal taxes, and other charges, equivalent to $32.34 a share earned on 452,960 shares of stock of $10 par value. This compares with $4,113,671, or $9.08 a share, on 452,760 shares in 1926. The market value of stocks of listed dividend paying corporations owned on Dec. 31, 1927, based on the last sale prices of that date on the exchanges, was $9,487,329 in excess of the cost to Newmont.

BUTTE COPPER & ZINC COMPANY report shows lower earnings in 1927. Profit of $58,309 after expenses and taxes, but before depletion, is equivalent to 9c. per share (par $5) earned on 600,000 shares of stock. For 1926, profit after expenses, depreciation and taxes was $194,524 or 32c. per share. Depreciation reserve as of Dec. 31, 1926, is reported equal to book value of plant. The 1927 and 1926 income accounts compare as follows:

	1927	1926
Ore receipts.....	$87,171	$275,923
Depreciation.....	.....	10,000
Balance.....	$87,171	$265,923
Other income.....	14,730	25,591
Total income.....	$101,901	$291,514
Expressing and taxes.....	43,592	96,990
Profit before depletion.....	$58,309	$194,524

HOWE SOUND COMPANY reports the following production from its Britannia mine, in British Columbia, and its Calera and El Potosi mines, in Mexico, for the last two quarters of 1927:

	Third Quarter	Fourth Quarter
Gold, oz.	2,709	3,018
Silver, oz. ..	727,428	808,542
Copper, lb. ..	8,907,430	9,242,919
Lead, lb.	17,009,966	19,180,971
Zinc, lb.	13,565,629	13,177,105

Below are comparative income accounts for the quarters:

	Third Quarter	Fourth Quarter
Value of metals produced	$3,309,712	$3,438,838
Operating costs	2,653,819	2,798,102
Operating income ...	$655,893	$640,736
Miscellaneous income	83,011	78,388
Total income	$738,904	$719,124
Less depreciation ...	235,557	266,764
Net income	$503,347	$452,360

CHIEF CONSOLIDATED MINING COMPANY, operating in the Tintic district, Utah, reports decreased earnings for 1927, but the outlook during the last quarter acquired a more favorable aspect. Earnings were appreciably lower in 1927, compared with the record postwar year 1926. For 1926 the net earnings were $564,680.51; in 1927, $233,081.48. All dividends were passed in 1927, the first yearly lapse since dividends were started in 1913. Improvement in present conditions is reflected in the dividend payment made on Feb. 1, 1928, at the regular 10c. per share, quarterly rate. The No. 1 Mine, as a unit, at Eureka, has been leased to Basil Prescott, consulting geologist of El Paso, Tex., who plans a vigorous development campaign. The Plutus and Eureka Lily properties, Chief Consolidated subsidiaries, are reported in excellent condition. The volatilization plant continues to operate on oxidized ore.

The Market Report

Moderate Metal Buying at Slight Price Concessions

New York, Feb. 8, 1928—The general tone of the metal market is quiet, with prices slightly easier than a week ago. The situation in copper and lead is practically unchanged since early in December; zinc and silver have declined slightly in the two months; and tin is several cents lower, a condition that is beginning to stimulate sales.

Copper-Buying Spurt Was Short Lived

Copper sales were very satisfactory last Wednesday, Thursday, and Friday, with the result that members of the producing group that has been holding for some time at 14⅛c. delivered in the East and 14.25c. in the Middle West were able to book several orders at those levels. A large buyer entered the market for prompt shipment, cleaning up much of the spot copper in sight at varying prices between 14.075c. and 14.125c. The lower quotation mentioned has been made by one seller all week, and the market in the last two days has settled down to that level, so far as actual business is concerned, the 14⅛c., Valley, quotation of the large producing interests being largely nominal for the time being. The continued decline in the London standard market has, with reason or not, had some effect on consumers, though without doubt they must enter the market before long. Copper sales have been well below normal since early December, and March requirements must, in large part, be as yet unprovided for. Practically all the copper sold this week has been for February or March shipment, indicating an underbought condition. The foreign market has been quiet so far this month, at unchanged quotations of 14½c., c.i.f. The indications are that an improvement in the foreign market may be coincident with a domestic buying wave later in the month, a condition similar to that which existed in November.

Consumers of copper report advance bookings of sheet copper and brass as somewhat less than expected, though plant operations are continuing with little or no change. Wire mills, on the other hand, have found some improvement in conditions.

No Interest in Zinc

Neither sellers nor buyers seem to be taking much interest in zinc these days, the quotations for the last two months having fluctuated within the narrow limits of 5.60@5.70c., with little zest in the market. Foreign trade in zinc seems to be better than domestic so far this year. Quotations on metal for forward delivery have been, in some instances, 2½ points above those for prompt, and dealers have been accumulating a little at current levels, indicating at least some hope for better conditions in the future. The Tri-State ore market, too, is slightly higher. Spot lots of High-Grade are nominally unchanged at 7¾c. for Eastern deliveries.

Lead Market Dull

A comparatively small quantity of lead changed hands during the week ending today. It is significant, however, that virtually every transaction was for prompt shipment and many of the orders were marked "immediate." With prices in London continuing to soften, domestic buyers apparently feel that a decline on this side may develop, and for that reason they are buying only to meet urgent current needs. Producers, on the other hand, are confident that consumption is and will be close to average and that buying on a good scale is to be expected soon. They feel that the price is in reality low and are content to await developments. Of course, a drastic drop in London would

Daily Prices of Metals

Feb.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
2	13.85@13.925	53.75	54.375	6.50	6.225@6.25	5.625
3	13.85@13.925	53.625	54.00	6.50	6.225	5.625@5.65
4	13.85@13.925	53.25	53.75	6.50	6.225	5.65
6	13.85@13.925	53.125	53.625	6.50	6.225	5.65@5.675
7	13.85	52.50	53.125	6.50	6.20@6.225	5.625@5.65
8	13.85	52.25	52.75@53.25	6.50	6.225	5.625@5.65
	13.875	53.083	53.646	6.50	6.225	5.642

Average prices for calendar week ending February 4, 1928, are: Copper, 13.888; 99 per cent tin, 53.813; Straits, 54.292; N. Y. lead, 6.500; St. Louis lead, 6.240; zinc, 5.656; and silver, 56.729.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for ordinary form of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.13c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Feb.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Spot	3M	Spot	3M	Spot	3M
	Spot	3M							
2	62½	61⅞	66½	245	245⅜	20 15/16	21⅜	25¼	25 13/16
3	62⅜	61⅞	66½	245¼	246	21⅛	21⅝	25⅞	25⅞
6	62¼	61⅜	66½	242⅝	243⅛	21 1/16	21⅛	25⅞	25⅞
7	62	61½	66½	238¾	240¼	20 13/16	21 1/16	25 13/16	25 13/16
8	61⅝	61¼	66½	236	238	20 13/16	21 1/16	25 11/16	25 11/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Feb.	Sterling Exchange "Checks"	Silver		Gold London	Feb.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
2	4.86¾	56¾	26 3/16	84s11 1/2d	6	4.86 13/16	56½	26 1/16	84s11½d
3	4.86½	56⅝	26⅛	84s11½d	7	4.86 13/16	56¾	26⅛	84s10½d
4	4.86⅝	56½	26⅛	.....	8	4.86 11/16	56¾	26⅛	84s11½d
					Avg.		56.646		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths of a cent premium.

change the complexion of the situation. Prevailing prices have been 6.50c., at which figure the American Smelting & Refining Company has maintained its contract price in New York, and 6.225c. in St. Louis. Some metal has been available at 6.20c. in the Middle West, but the tonnage is not large, and, on the other hand, 6.25c. has been realized on a number of miscellaneous orders. If there is any tendency to shade the price in New York, it is only in a small way. There is evidence that certain cable companies will require more lead this year than last and the storage-battery business is said to be looking up. Interest by paint makers, on the other hand, continues dull.

Tin Prices Decline

Tin continues its downward course, and prices sank lower than at any other time in the last three years. Since Jan. 2 Standard tin in London has declined £28 for spot and £24 for futures. Today a contango of £2 prevails, instead of a strong backwardation. Consumers as well as dealers have bought in the domestic market during the week with the thought that an upward reaction is not unlikely to develop. On this side there is little difference in prices for spot and future. Tin of 99 per cent grade is not plentiful, nor is it as scarce as it was a week ago, and the spread between the two grades is upward of ½c.

This afternoon buying became active and 800 to 1,000 tons was sold, the price for Straits advancing during the day from 52¾ to 53¼c.

Silver Quiet and Steady

Silver continues quiet, but there is great steadiness to the market in London and New York. China has been a buyer during the week, and though Indian rates have improved slightly, no orders have been received from that quarter. The closing tendency is quiet and steady.

Mexican Dollars (Old Mexican pesos): Feb. 2d, 43⅜c.; 3d, 43¼c.; 4th and 6th, 43⅛c.; 7th and 8th, 43⅜c.

Foreign Exchange Steady

Closing cable quotations on the principal foreign exchanges other than sterling, on Tuesday, Feb. 7, were: francs, 3.92⅛c.; lire, 5.29¼c.; marks, 23.86c.; Canadian dollars, ⅛ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

ALUMINUM—Per lb., 98 or 99 per cent grades, price of leading interest, 24.30c.; outside market, 23.90@24.30c.

ANTIMONY—Per lb., duty paid. New York: Chinese brands, spot business, range for the week 11¼@11c. Forward positions through April about ⅛c. higher. Cookson's "C" grade, spot, 16⅛c. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, Chinese, 99 per cent Sb_2O_3, 15½c.

BISMUTH—Per lb., New York, in ton lots, $2.20. Smaller lots, $2.30 and up. London price advanced from 8s. to 9s. on Feb. 3.

IRIDIUM — Per oz., $390@$415 for 98@99 per cent sponge and powder. Strong market; shortage of supply.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.9 per cent grade) for single lots of spot metal. Contracts for 1928 have recently been made at 30@33c. per lb. for ingot, depending upon quantity; and at 34½@35c. per lb. for electrolytic.

PALLADIUM—Per oz., $49.50@$51.50. Small lots bring up to $56.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $85. Dealers and refiners quote the trade for refined metal, per oz., cash, $82@$85. Market moderately active.

QUICKSILVER — Per 76-lb. flask, $121@$122, depending on quantity, consumers taking more interest at the lower levels. Sellers in Europe do not seem to be influenced by the outside liquidation. San Francisco wires $125.

RHODIUM—Per oz., $60@$65.

RUTHENIUM — Per oz., $70@$75. Market strong.

Prices of Cadmium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Feb. 4.

Metallic Ores

MANGANESE ORE—Per long ton unit of Mn. c.i.f. North Atlantic ports, minimum 47 per cent Mn; 35@38c. Caucasian, washed, 53@55 per cent, 38.50@40c. Chemical grades unchanged from quotations in the Feb. 4 issue.

TUNGSTEN ORE—Per unit of WO_3, N. Y.; Wolframite, $10.25@$10.50. Western scheelite, $10.50@$10.75. Market dead; prices nominal.

Chrome, Iron, Tantalum, and Titanium ores are unchanged from quotations in the Feb. 4 issue.

Zinc Ore Prices Advanced $1 in Joplin

Joplin, Mo., Feb. 4, 1928.—Large purchases of blende during the week established the base price at $38, an advance of $1 from the preceding week, Prime Western 60 per cent basis. Total purchases were 14,340 tons, against a production of 12,000 tons. Sales were the largest for many weeks and producers are taking a firmer stand. Details of production and prices of various grades and of values will be published next week.

Platteville, Wis., Feb. 4, 1928

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$39.75
Lead Ore	
Lead, basis 80 per cent lead	$85.00

Shipments for the week: Blende, 779 tons; lead, 120 tons. Shipments for the year: Blende, 3,507; lead, 360 tons. Shipments for the week to separating plants, 1,013 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the Feb. 4 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic)—Per lb., 4c. A few good sales made.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Feb. 4 issue.

Ferro-Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or c.i.f. port of entry, $100 quoted for first quarter, 1928. Spiegeleisen, 19@21 per cent, $31@$32 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent, 92@94c. f.o.b. works. Dullness expected for several months.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the Feb. 4 issue.

Metal Products

Rolled copper, lead sheets, nickel silver, yellow metal and zinc sheets are unchanged from price in Feb. 4 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the Feb. 4 issue.

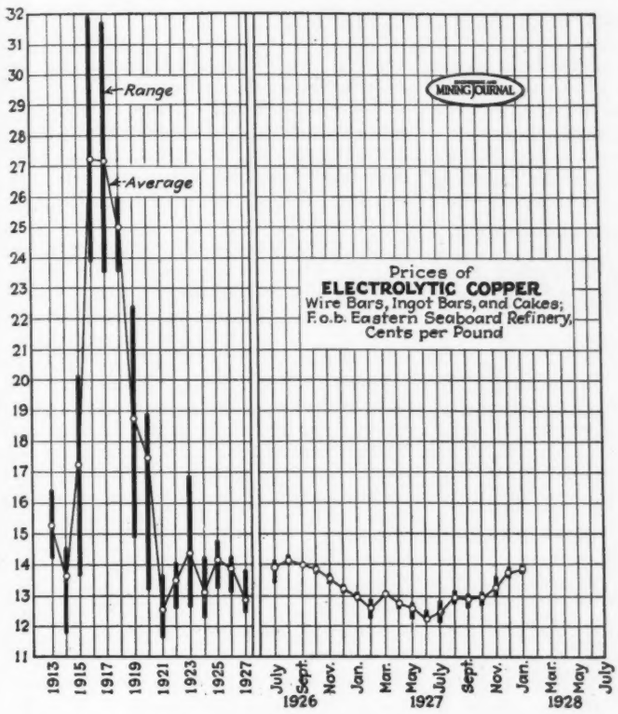
Iron, Steel, and Coke

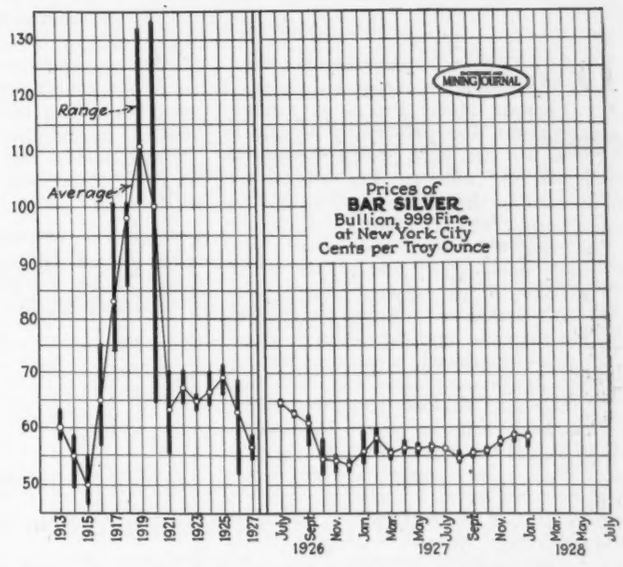
Iron—Per gross ton, Valley furnaces, Bessemer, $17.50; basic, $17; No. 2 foundry, $17.25.

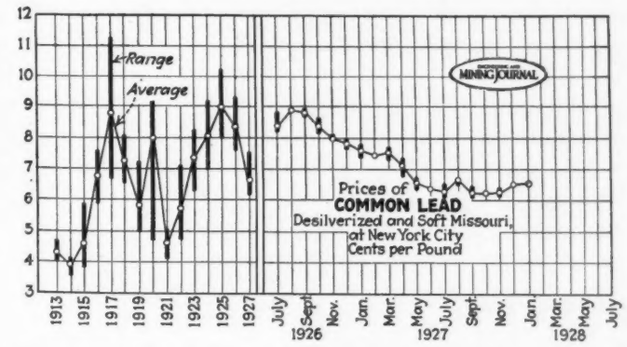
Steel—Base prices per gross ton, Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per pound, 1.85c.@1.95c.

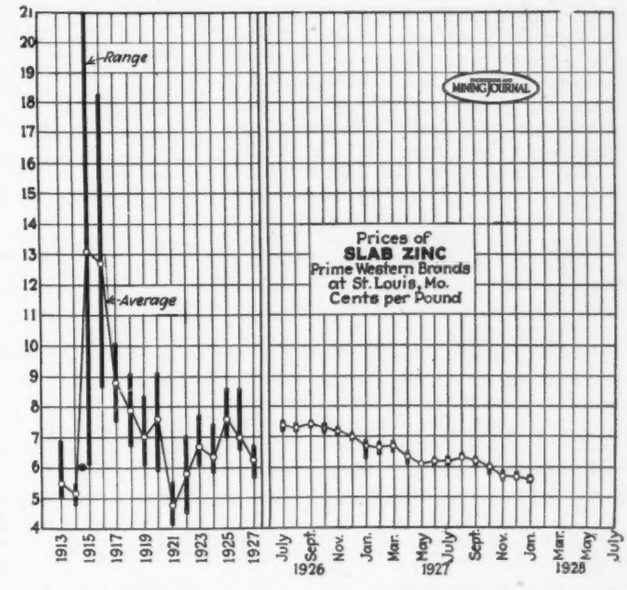
Coke—Per gross ton, Connellsville furnace, contract, $2.85@$3; spot, $2.60@$2.75. Connellsville foundry, contract, $3.75@$4.25; spot, $3.75@$4.25. By-product coke, Ohio and Kentucky, $7.50; Buffalo and Detroit, $9.

Metal Price Curves

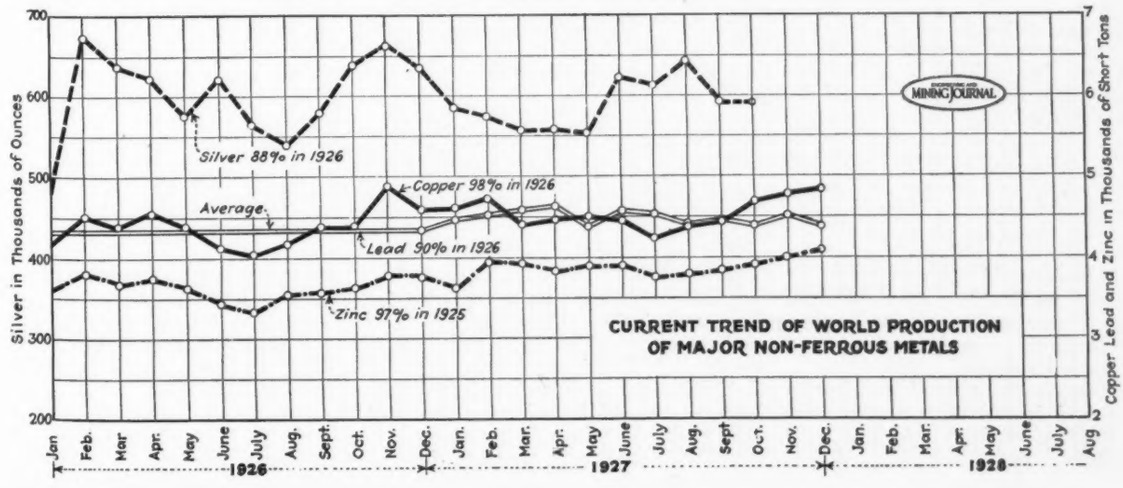








THE CURVES below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output according to the latest estimates of the American Bureau of Metal Statistics. The figures represent production from countries that produce approximately 98 per cent of the world's copper, 97 per cent of the zinc, 90 per cent of the lead, and 88 per cent of the silver. The figures for lead on the new basis are not available for the individual months of 1926, and accordingly a horizontal line showing the monthly average reduced to a daily rate is shown. Delay in receipt of statistics from Mexico accounts for the failure of the silver curve to be up to date.



Review of Current Statistics

By A. B. Parsons
Associate Editor

DECLINE in *Engineering and Mining Journal's* Weighted Index of Non-Ferrous Metal Prices in January is accounted for principally by lower figures for the high-priced metals, as indicated in Table I. Tin, silver, and aluminum in the order named were the chief contributing factors. Zinc declined slightly; lead and nickel were virtually unchanged; and copper, which on account of its relatively high price and the immense tonnage has more weight than the next three—lead, silver, and zinc—combined, averaged slightly higher in January than in December. The table also discloses some interesting comparisons between prices in January of 1927 and the same month of the current year. Only copper and silver are higher. Nickel is unchanged, and the others are all distinctly lower. But for the advantage of about ⅞c. per pound for copper in 1928, the Index would be lower than at any time since 1922.

Copper may not be in quite so favorable a position as the price (13.854c. against 13.774c. for December and 12.99c. for January, 1927) would seem to indicate, principally because of the slimness of the volume of sales in the domestic market at the higher prices that have prevailed since mid-December. If the average of the weekly sales reported to *Engineering and Mining Journal* for the entire year 1927 be taken as 100, the average for the eight weeks just passed has been only 49. This incidentally compares with 86, on the same basis, for the corresponding period one year ago. At the same time the sales for the eight-week period immediately preceding the latest were 148. Manifestly, some let-up was to be expected; and the position of the sellers was such that a dull period could be weathered, especially with the tonnage sold in the foreign markets holding up well. To what extent this protracted dullness reflects a shrinkage in the requirements of fabricators is problematical. In any event the major producers feel that they will ultimately get just as much business if they hold out for their price as if they start cutting. That seems sound reasoning; but it takes courage to carry out such a policy. December statistics showed a fifth consecutive increase in the rate of world production; and history shows only one month—November, 1926—when the rate was exceeded. Both November and December showed some increase in stocks in North and South America, but the total still is far below the modest peak reached in February, 1927.

Steadiness is the outstanding feature of lead. Since the American Smelting & Refining Company advanced its contract price from 6.40 to 6.50c. on Dec. 1, 1927, variations from that figure have been inconsequential. Statistics show a decline in world production for December and a continuation of the decline in stocks at refineries and smelters in the United States and Mexico. Production at smelters in North America is also slightly lower. Statistically lead is in better position than either copper or zinc, it would appear.

Zinc has been going down steadily since August, and at 5.643c. is lower than at any time since 1922, and more than one cent below the average for January, 1927. The accompanying charts show that, according to latest available statistical data, domestic production is steadily increasing, that shipments of slab zinc as well as of ore and dross to foreign countries are almost negligible, and that stocks are increasing. At the end of December they were only a little under the peak reached last June. World production rate also continues its upward trend with a persistence that is disappointing to producers.

Silver declined during January as a consequence of the lessened demand from China in the latter part of the month, following the Chinese new year. Aluminum suffered no further reduction during January, but the average for the month is lower than that for December because of the cut made in that month. Tin is off decisively. Supplies of Straits are adequate, and although domestic demand both for tin-plate and automobile manufacturing purposes is somewhat improved, consumers feel no anxiety, and the speculative support from London has not operated to maintain the price level. Nickel of the fire-refined variety is unchanged, although the International Nickel Company, incidentally, reduced the spot price of electrolytic from 39c. to 37c. per pound effective Jan. 1.

Fluorspar was the only item to change in the list that comprises the Non-Metallic Mineral Index. The decline brought the Index to 105.84, which compares with 106.21 in December and with 105.21 in January a year ago.

International Nickel, abetted only a little by National Lead, caused the Index number for the share prices of mining-smelting-manufacturing companies to climb, contrary to the general tendency toward reaction in the stock market. There seems to be little change in the situation at the Nickel properties in Ontario, but the public in Canada and the United States has a keen appetite for the shares—so keen in fact that demand has bid the price up to the point where the common stock has a "valuation" greater than that of American Smelting & Refining and approximately equal to that of Anaconda. Both of these eased off in January, as did U. S. Smelting, and American Metal. Table II shows some interesting comparisons in the prices of the shares of the seven companies in this group. It should be pointed out that National Lead shares were split in such a way that the apparent decline does not reflect a reduction in the aggregate share value.

Without a single exception the companies represented in the Copper Share Index were lower at the end of January than at the start, the reason being doubtless the reaction in the general list in the stock market. More recently another upward movement has started. Nevada Consolidated is particularly bouyant; the Street senses absorption by Kennecott and has even figured the basis of exchanging shares at 3.1 of Nevada for 1 of Kennecott.

In the miscellaneous group, advances and more numerous than declines, although the net result is a lower index. Prominent Ontario gold shares underwent some deflation, and, with Cerro de Pasco, accounts largely for the decline. On the other hand, Utah and Idaho lead-silver companies showed strength. Tintic Standard being the leader and reaching a new high.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54

	1926	1927	1928
June	106.68	95.55	——
July	109.08	95.42	——
August	110.22	97.25	——
September	109.27	96.01	——
October	106.20	95.36	——
November	104.21	96.22	——
December	102.31	98.30	——
January	112.66	100.46	97.54

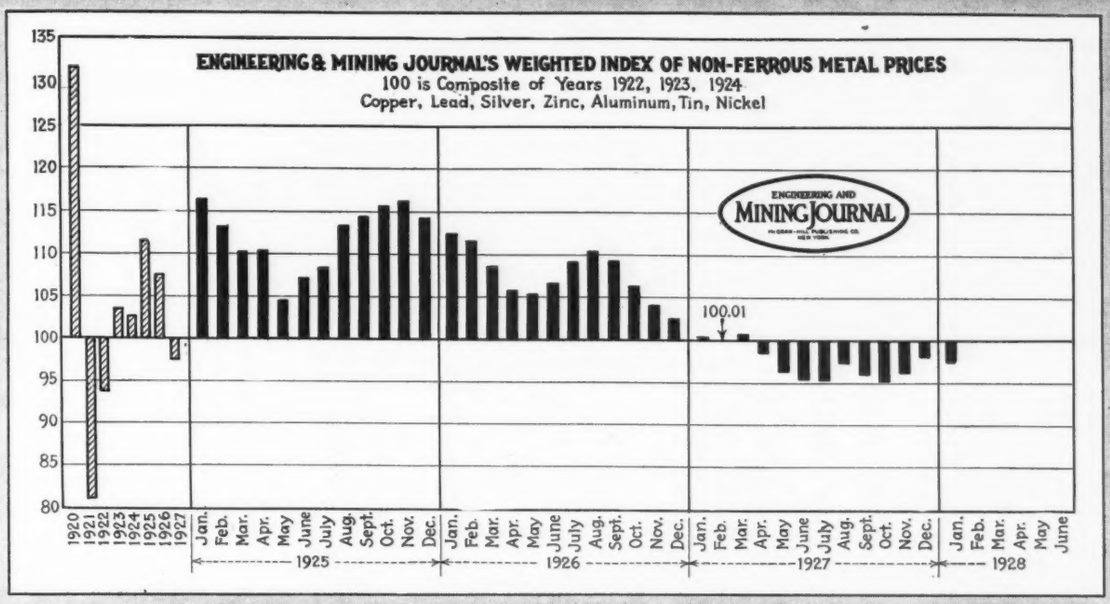
Table I—Comparative Metal Prices

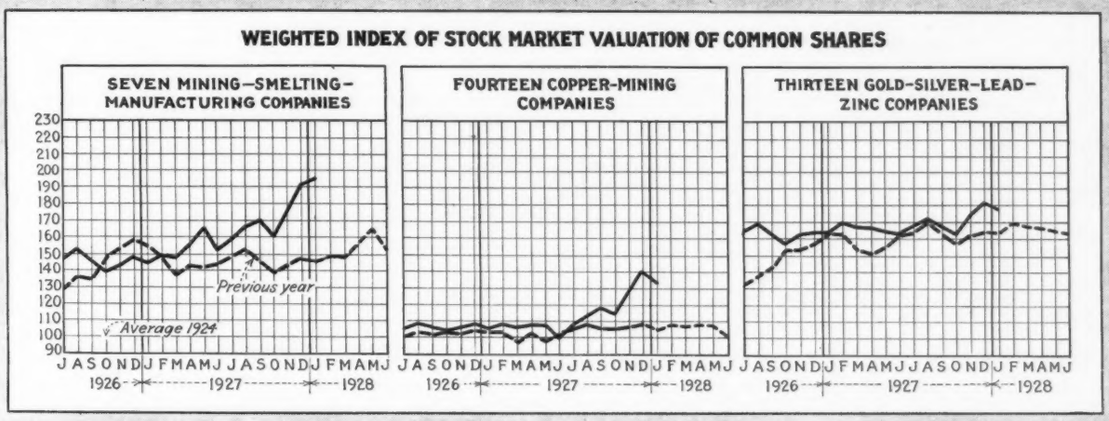
	1927		1928
	January	December	January
Copper	12.990	13.774	13.854
Lead	7.577	6.504	6.500
Silver	55.795	57.957	57.135
Zinc	6.661	5.722	5.643
Aluminum	26.270	24.785	24.300
Tin	66.415	58.452	55.650
Nickel	35.000	35.000	35.000
E. & M. J weighted index	100.46	98.30	97.54

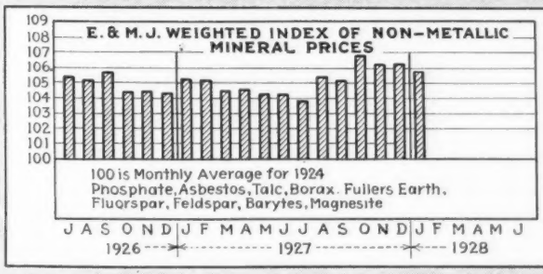
Table II—Comparative Share Prices

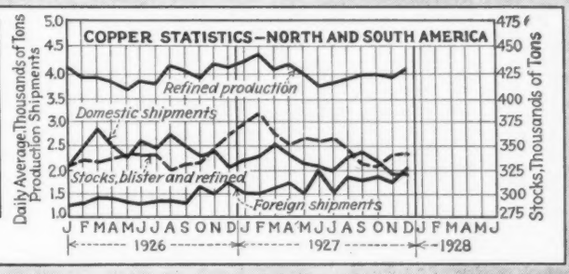
	1927		1928
	January	December	January
Anaconda	47⅛	58¼	55⅛
A. S. & R.	137¼	182¼	176½
N. J. Zinc	185	185	185½
Internat. Nickel	40	85⅞	97⅛
National Lead	162	129	132⅜
U. S. Smelting	33⅜	44⅜	42
American Metals	42	46⅛	43⅛
E. & M. J. weighted index	144.5	192.4	194.4

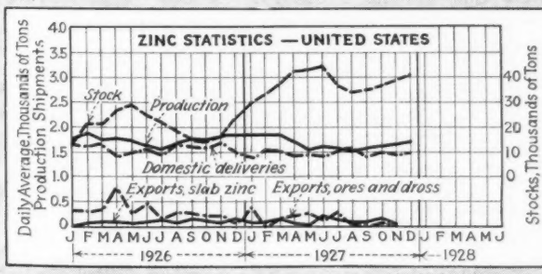
E.&M.J. Statistics of the Mining Industries

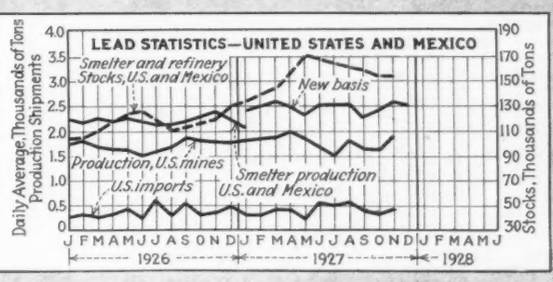





E. & M. J. WEIGHTED INDEX OF NON-METALLIC MINERAL PRICES
100 is Monthly Average for 1924
Phosphate, Asbestos, Talc, Borax, Fullers Earth, Fluorspar, Feldspar, Barytes, Magnesite
1926
1927
1928







Mining Stocks—Week Ended February 4, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	57⅞	55	56⅛	Ja.14, Fe.20 Q	0.75
Arcadian Consol.	Boston	4	3⅛	4		
Ariz. Com'l	Boston	5⅛	5⅛	5⅛	Ja. 19, Ja. 31	0.25
Calumet & Hecla	Boston	23½	21½	22⅞	No.30, De.15 Q	0.50
Cerro de Pasco	New York	66⅛	64½	64⅜	Ja.12, Fe.8 Q	1.00
Chile Copper	New York	41⅛	40	40⅛	Ma. 2, Ma. 30Q	0.62
Con. Coppermines	N. Y. Curb	5⅞	5⅛	5⅛		
Copper Range	Boston	18⅛	17⅞	17⅞	Ap.2, My.2, A	1.00
Crystal Copper	Bos tonCurb	*69	*54	*60		
East Butte	Boston	1⅞	1½	1½	Dec. 1919	0.50
Granby Consol.	New York	41½	39⅜	40	Jn.15 Jy. 1 Q	1.00
Greene Cananea	New York	145⅜	134½	138	Nov., 1920	0.50
Howe Sound	New York	45⅜	42	43⅛	De.31, Ja.16, Q	1.00
Inspiration Consol.	New York	19½	19	19⅛	Ma.17, Ap.4, Q	0.25
Iron Cap	Boston Curb	2⅛	2⅛	2⅛		
Isle Royale	Boston	13⅛	13	13⅛	Fe. 28, Ma. 15	0.50
Kennecott	New York	83½	81⅛	82⅝	De. 2, Ja 3 Q	1.25
Magma Copper	New York	52⅜	49	49⅜	De.30, Ja.17 Q	0.75
Mason Valley	N. Y. Curb	1⅜	1⅜	1⅜		
Miami Copper	New York	19⅛	18	18⅛	Fe.1, Fe.15, Q	0.37½
Mohawk	Boston	47½	46½	47	Ja. 28, Ma. 1 Q	1.00
Montana-Idaho	Spokane	*50½	*49	*50½		
Mother Lode Coal	New York	2⅛	2⅛	2⅛	De.16, De.31	0.25
Nevada Consol.	New York	22½	18⅛	22⅛	De.16, De.31 Q	0.37½
New Cornelia	Boston	28⅜	28⅛	28⅛	Fe. 3, Fe. 20 Q	0.50
Noranda	N. Y. Curb	21	20	20		
North Butte	Boston	1⅛	*99	1.00	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*94	*90	*92	Sept. 1926	0.03
Old Dominion	Boston	11	10	10⅜	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	124	123	123	De.17, Ja.3 Q	1.50
Quincy	Boston	14½	13⅛	14	March, 1920	1.00
St. Mary's Min. Ld.	Boston	30	29	29⅛	Fe.10, Ma.10	2.00
Seneca Copper	New York	2⅜	2⅛	2⅛		
Shattuck-Denn	Boston Curb	14	12	12⅜		
Tenn. C. & C.	New York	10⅞	10⅛	10⅜	Fe.29, Ma.15, Q	0.12½
United Verde Ex.	N. Y. Curb	23⅜	23⅛	23⅛	Ja.4, Fe.1 Q	0.50
Utah Copper	New York	...	...	145	De.16, De.31 Q	1.50
Utah Metal & T.	Boston	1⅜	1⅛	1⅛	Dec., 1917	0.30
Walker Mining	Salt Lake	1.47½	*72	1.37½		
NICKEL-COPPER						
Internat. Nickel	New York	99⅛	94⅜	95⅛	De.16, De.31 Q	0.50
Internat. Nickel pfd.	New York	112	112	112	Fe. 17, Ma. 1 Q	0.62½
LEAD						
Gladstone Mtn.	Spokane	*14	*7	*7	June, 1927	0.005
National Lead	New York	136	132	134½	Dec. 16, De. 31 Q	1.25
National Lead pfd.	New York	113½	113½	113½	Ma. 2, Ma. 15Q	1.75
St. Joseph Lead	New York	42⅛	41	41	Ma.9, Ma.20, QX	0.75
ZINC						
Am. Z. L. & S.	New York	11	8	8	May, 1917	1.00
Am. Z. L. & S. pfd.	New York	67½	51½	58	Nov., 1920	1.50
Butte C. & Z.	New York	4⅛	4⅛	4⅛	De. 9, De. 24	0.50
Butte & Superior	New York	10⅛	9⅛	10⅛	De.16, De.31 Q	0.50
Callahan Zn-Ld.	New York	2⅜	2⅛	2⅛	Dec., 1920	0.50
Consol.Lead&Zinc'A'	St. Louis	14⅜	14	14	Ma.15, Ap.1 Q	0.25
Eagle-Picher	Cincinnati	22	21⅛	21⅛	No.15, De.1 Q	0.40
Eagle-Picher pfd.	Cincinnati	118	118	118	Jn.30, Oc.15 Q	1.50
New Jersey Zn.	N. Y. Curb	195	185½	194⅛	Ja. 20, Fe. 10	2.00
United Zinc	N. Y. Curb	27	25	25		
Yellow Pine	Los Angeles	*25	*25	*25	Dec. 1925 Q	0.04
GOLD						
Alaska Juneau	New York	4⅛	3	3⅛		
Argonaut	Toronto	*27	*23½	*24½		
Barry-Hollinger	Toronto	*90	*74	*84		
Central Manitoba	Toronto	1.76	1.55	1.66		
Con.W.Dome L. new.	Toronto	*14⅛	*12½	*14		
Cresson Consol. G.	N. Y. Curb	2⅛	2	2⅛	Ma.31, Ap.10 Q	0.10
Dome Mines	New York	12⅜	11⅞	12	Ma. 31, Ap. 20Q	0.25
Golden Cycle	Colo.Springs	†1.75	†1.73½		No.30, De.10 Q	0.04
Gold Hill	Toronto	*31½	*20	*26½		
Hollinger Consol.	Toronto	18.00	17.45	18.00	Fe.9, Fe.25 M	0.10
Homestake Mining	New York	69	69	69	Ja.20, Ja.27 MX	1.50
Kirkland Lake	Toronto	2.35	1.93	2.10		
Lake Shore	Toronto	25.00	24.35	24 40	De.1, De.15 QX	0.20
McIntyre-Porcupine	New York	28	28	28	Fe. 1, Ma. 1 Q	0.25
Portland	Colo.Springs	†*25	†*18	...	Ap.6, Ap.15, Q	0.02
Rand Mines	New York	...	...	43⅛	Au.22-29 Am.Sh.	1.52
Sylvanite	Toronto	3.40	3.20	3.40		
Teck-Hughes	Toronto	9.40	8.76	9.25	Fe.1, X	0.15
Tom Reed	Los Angeles	*36½	*33	*33½	Dec., 1926	0.02
Tough-Oakes	Toronto	*65	*51	*59		
United Eastern	N. Y. Curb	*71	*65	*70	July, 1924	0.05
Vipond Cons.	Toronto	*60	*55	*56	Apr.1, Apr.15	0.03
Wright-Hargreaves	Toronto	5.75	5 50	5.63	Ja. 17, Fe. 1	0.05
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	22⅞	21⅞	26½		
Con. Cortez	N. Y. Curb	...	...	*19		
Dolores Esperanza	N. Y. Curb	*55	*45	*47	July, 1923	0.05
Premier Gold	N. Y. Curb	2⅜	2⅛	2⅜	De. 15, Ja. 4	0.08
Tonopah Belmont	N. Y. Curb	1⅛	1⅛	1⅛	Ma.15, Ap.4	0.08
Tonopah Extension	N. Y. Curb	*11	*9	*10	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	4⅛	3⅛	3⅛	Se.20, Oc.2	0.07½
West End Consol.	N. Y. Curb	...	...	*5	Mar., 1923	0.05
Yukon Gold	Boston Curb	*60	*50	*60	June, 1118	0.02
SILVER						
Beaver Consol.	Toronto	1.94	1.52	1.72	May, 1920	0.03
Castle-Trethewey	Toronto	*81⅛	*68	*79		
Coniagas	Toronto	5 06	4.75	4.75	May, 1924	0.12½
Keeley	Toronto	*56⅛	*53½	*56⅛	Se.1, Se.15	0.06
Lorrain Trout Lake	Toronto	...	...	*60	July, 1925	0.05
Mining Corp. Can.	Toronto	4.95	3.95	3.95	Ja.16, Ja.25	1.50
Nipissing	N. Y. Curb.	5⅛	5⅛	5⅛	De. 21, Ja.20 Q	0.07½

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	3½	3	3⅛	Ma. 25, Ap.4, QX	0.12½
Bingham Mines	Boston	54	54	54	Ja. 21, Fe. 1 Q	0.95
BunkerHill&Sullivan	N. Y. Curb	152⅛	150	150	Ja.31, Fe.4 NX	0.75
Cardiff M. & M.	Salt Lake	*75	*70	*70	Feb 5, 1927	0.10
Chief Consol.	Salt Lake	3.65	3.45	3.65	Ja.10, Fe.1 Q	0.10
Consti'nMng.&Mill'g	Spokane	*28	*22	*22		
Erupcion	Boston Curb	*50	*50	*50	De.17, Ja.3 Q	0.07½
Eureka Lily	Salt Lake	2.25	1.82½	2.25		
Federal M. & S.	New York	...	...	147½	Jn.25, Jn.29	Spec. $10
Federal M. & S pfd.	New York	95	95	95	No. 12 De 15 Q	0.25
Hecla Mining	N. Y. Curb	18	17⅜	17⅜	No.15, De.15 Q	1.75
Highland-Surprise	Spokane	*16⅜	*16	*16		
Iron King Mining	Salt Lake	*70	*58	*70		
Keystone Mining	Salt Lake	*65	*25	*25	Au. 12, Au. 26	0.07½
Lucky Jim	Spokane	*34½	*34	*34½		
Lucky Tiger-Com	Kansas City	†8.10	†7.95	...	Fe.10, Fe. 20	0.07
Mammoth Mining	Salt Lake	2.05	2.05	2.05	Jn.10, Jn.20 Q	0.05
North Lily	Salt Lake	5.00	4.10	4.80		
Park Utah	New York	12⅜	11	11⅜	De. 15, Ja. 3 Q	0.20
Plutus Mining	Salt Lake	2.40	2.40	2.40	Oc. 25, No. 10 Q	0.10
Silver King Coal	Salt Lake	11⅛	11⅛	11⅜	De. 24, Ja.2 X	0.35
Silversmith	Spokane	*24⅛	*22	*24⅛	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*53⅛	*50	*50		
Sunshine M. Co.	Spokane	1.60	1.50	1.60		
Tamarack-Custer	Spokane	1.15	1.00	1.14	Sept., 1924	0.25
Tintic Standard	Salt Lake	15⅜	15⅛	15⅛	De.20, Ja.3 QX	0.40
Utah-Apex	Boston	4⅜	4⅜	4⅜	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	59	56⅛	58⅜	Se. 2, Oc. 1	1.75
Cleveland-Cliffs Iron	Cleveland	105	105	105	Ja.13, Ja.25. Q	1.00
Colorado Fuel & Iron	New York	84⅛	78⅛	79⅜	May, 1921	0.75
Gt. North'n Iron Ore	New York	93⅜	92	92	Dec. 6, Dec. 28	0.75
Inland Steel	New York	59⅛	56⅜	57⅜	Fe.15 Ma.1 QX	0.66⅔
Replogle Steel	New York	...	...	12⅜		
Republic I. & S.	New York	64⅜	61⅛	63⅛	Fe. 15, Ma.1 Q	1.00
Republic I. & S. pfd.	New York	110⅜	110⅛	110⅛	Ma. 15, Ap. 2 Q	1.75
Sloss-Sheffield S. & I.	New York	129½	127	129	De. 10, De. 20 Q	1.50
Sloss-Shef. S.&I. pfd.	New York	110⅜	110⅜	110⅜	De. 20, Ja.3 Q	1.75
U. S. Steel	New York	146⅞	142⅛	143⅛	No. 30, De. 30 Q	1.75
U. S. Steel, pfd.	New York	142	139½	139⅜	Oc.30, No. 29 Q	1.75
Virginia I. C. & C.	New York	...	...	38	Jan., 1924	1.50
Virginia I.C.&C. pfd.	New York	...	...	62⅜	De. 16, Ja. 3	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol.	New York	...	...	24	Jn. 26, Jn.30	1.45
So. Am. G. & P. New.	N. Y. Curb	3	2⅜	2⅜		
Alum. Co. of Amer.	N. Y. Curb	129⅜	124	124		
Alum. Co. ofAmer.pf.	N. Y. Curb	107	106⅜	107	De. 15, Ja1 Q	1.50
Vanadium Corp.	New York	87	70	87	Fe. 1, Fe. 15 Q	0.75
Patino M. & E.	New York	30⅜	26⅛	26⅜	De 31, Ja. 14	4s.
ASBESTOS						
Asbestos Corp.	Montreal	37	33⅛	35⅛	Jan., 1926	1.50
Asbestos Corp. pfd.	Montreal	95	93⅛	95	De.31, Ja.16 Q	1.75
SULPHUR						
Freeport Texas	New York	103⅜	94⅜	96	Ja.14, Fe.1 QX	1.75
Texas Gulf	New York	75⅛	71⅛	72⅛	De. 1, De. 15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	46	43⅜	43⅜	Fe.18, Ma.1 Q	0.75
Amer. Metal, pfd.	New York	117⅛	115⅛	116⅛	Fe.18, Ma.1 Q	1.75
Amer. Sm. & Ref.	New York	177⅜	173⅛	173⅜	De.31, Fe. 1 Q	2.00
Amer. Sm. & Ref. pfd.	New York	135	134⅜	135	De.31, Ma.1 Q	1.75
Consol. M. & S.	Montreal	287	273	280⅛	De. 31, Ja. 16 X	6.25
Newmont Mining	N. Y. Curb	164⅜	146⅛	157	Ja.3, Ja. 17	1.00
U. S. Sm. R. & M.	New York	42⅜	41	41	Ja. 6, Ja. 14 Q	0.87½
U.S. Sm. R.&M. pfd.	New York	53⅛	53	53	Ja. 6, .J3 14 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED JANUARY 24, 1928

Name	High	Low	Last	Date	Amount	Last Div.
Aramayo Mines (25 frs.)	71/3	68/9	70/—	Feb., 1928	5	p.c. (†)
British Platinum (£1)	—/3	—/1½	—/3	Feb., 1925	2½	p.c.
Burma Corpn. (10 rupees)	14/3	13/9	14/—	Jan., 1928	6	annas*
Bwana M'Kubwa (5s)	4/10½	4/4½	4/6			
Camp Bird (2s)	3/10½	3/7½	3/9			
El Oro (£1)	3/7½	3/—	3/7½	Nov., 1924	2	p.c.*
Esperanza (10s)	—/1½	—/1½	—/1½			
Frontino & Bolivia (£1)	14/3	13/9	13/9	Jan., 1928	5	p.c
Mexican Corpn. (£1)	8/9	8/3	8/9			
Mexico Mines of El Oro (£1)	18/1½	16/3	17/6	Dec., 1926	3½	p.c.*
N'Changa Copper Mining	11/—	10/—	10/—			
Oroville Dredging (£1)	4/1½	3/10½	4/1½	Dec., 1923	3½	p.c.
Ouro Preto (£1)	2/6	2/3	2/6	May, 1925	2½	p.c.
Rhodesian Congo Border (£1)	30/—	26/3	28/9			
St. John del Rey (£1)	10/1½	9/7½	9/9	May, 1927	3½	p.c.
San Francisco Mines (10s)	26/4½	25/(	25/9	Jan, 1928	25s.	
Santa Gertrudis (£1)	16/—	15/6	15/5	Jan., 1928	7½	p.c.
Selukwe (2s. 6d.)	8/1½	7/9	7/10½	April, 1917	6¼	p.c.
S. Amer. Copper (2s.)	—/7•	—/4½	—/7½	Nov., 1917	75	p.c.
Tanganyika (£1)	72/10½	65/7½	68/1½	Aug., 1927	7½	p.c.
Union Miniere du Haut-Katanga (Brussels)	12525	11.400	11.875	July, 1927	182.60	(‡)

* Free of British income tax. † Swiss francs and plus 15 p. c. bonus. ‡ Belgian frs. and free of taxation.